DRE-135

LAKE OKEECHOBEE
WATER QUALITY MANAGEMENT PLAN

Alternatives Evaluation

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Alternatives Evaluation

Prepared by
South Florida Water Management District
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I. INTRODUCTION

A. General Description of Lake Okeechobee Region

Lake Okeechobee lies about 30 miles from the Atlantic coast and approximately 60 miles from the Gulf of Mexico. The large, roughly circular lake, with a surface area of about 700 square miles, is the principal natural reservoir in southern Florida. Major tributaries to the lake are the Kissimmee River (C-38), Indian Prairie Canal (S-72 Basin), Harney Pond Canal (S-71 Basin), Fisheating Creek, and Taylor Creek/Nubbin Slough through S-191 and S-133. The largest outlets from the lake to the Gulf of Mexico and the Atlantic Ocean are channels to the headwaters of the Caloosahatchee River and St. Lucie Canal, respectively. The three major canals at the south end of the lake -- Hillsboro, North New River, and Miami -- provide for delivery of water south to Water Conservation Areas 2 and 3 and the coastal areas. Pump stations 2 and 3 provide the ability to pump water into the lake from the areas adjacent to and south of the lake during times of excess rainfall for water storage purposes.

Within the study area there are 17 major drainage basins surrounding Lake Okeechobee. The Lower Kissimmee Valley is served by the Kissimmee River or C-38. There are five pools in this area named for the structures which serve them: S-65A, S-65B, S-65C, S-65D, and S-65E. Three basins serve the Everglades Agricultural Area: S-2, S-3, and S-4. Adjacent to these basins are five private drainage districts which are connected by culverts directly to the lake: East Beach Water Control District, 715 Farms, East Shore Drainage District, South Shore Drainage District, and South Florida Conservancy District (S-236). Figure 1 depicts the Lake Okeechobee surface water drainage basins.

Soils, Topography, and Rainfall

Generally, flatwoods cover most of the northern and western areas tributary to the lake. Most of the elevations are below 100 feet and gradually decrease in a southerly direction to approximately 15 feet mean sea level at Lake Okeechobee. The soils are predominantly sandy surface layers, which combined with high water tables and relatively flat topography, provide for poor drainage. Surface water moves slowly through a system of streams and sloughs over much of the area; wetlands are common in many areas. A few small ridges have well-drained soils.

The Everglades occupies the southern basins adjacent to the lake. This area is nearly level, generally treeless, with an elevation between 14 to 16 feet mean sea level. The soils are organic and are underlain by limestone at a depth that ranges from 2 to 8 feet. These soils have been drained and water stands on the surface for only a short time. Having been drained, the organic soils are subject to oxidation and subsidence. Although initial subsidence is rapid and brief, the soil continues to subside at the rate of approximately one inch per year because of oxidation. To slow the rate of subsidence, high water tables are maintained to the extent possible for all uses.

The area has long, warm, relatively humid summers and mild, dry winters. The average annual rainfall is about 50 inches and is seasonally distributed with about 60 percent of the average total falling in the summer rainy season,

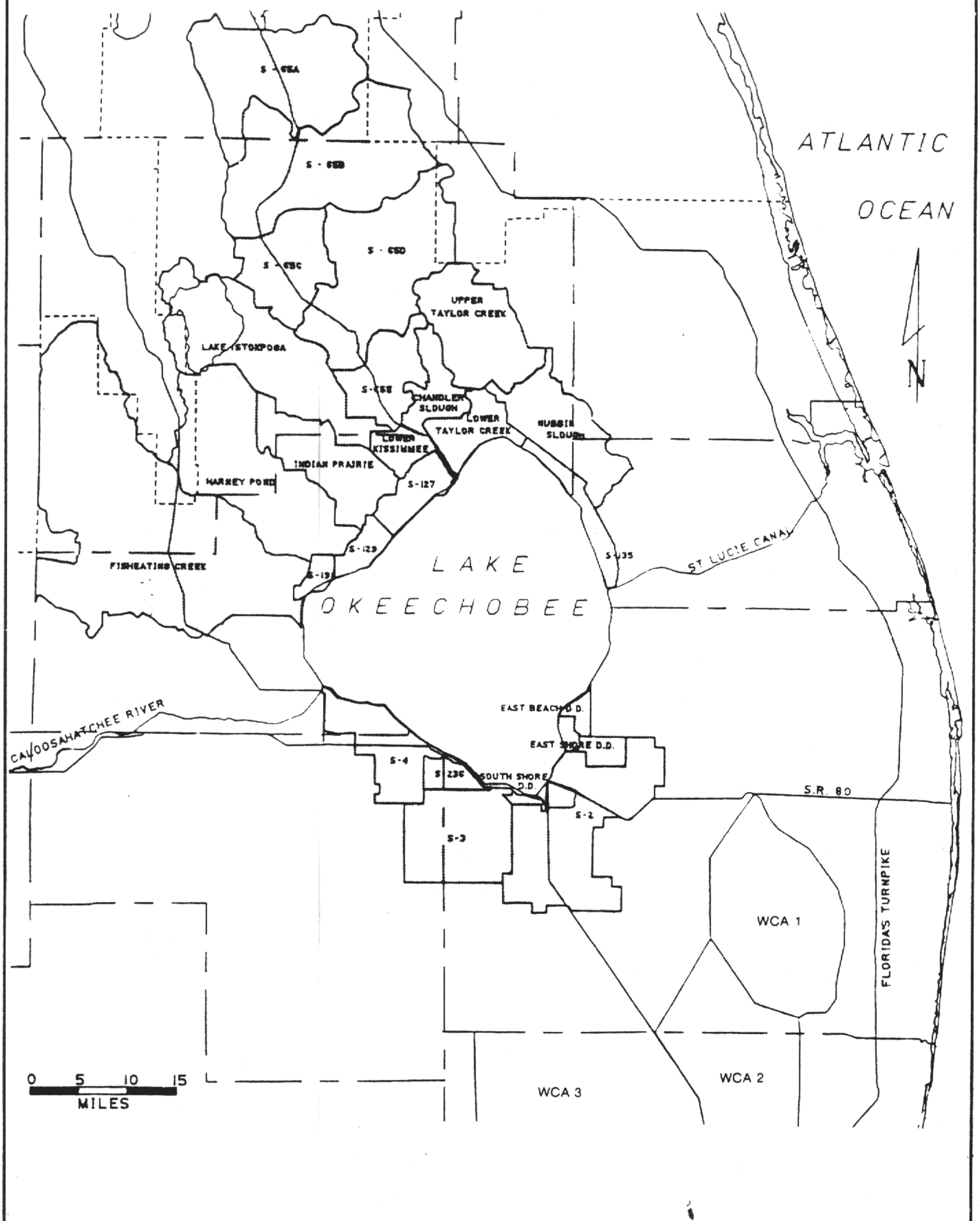


Figure 1 LAKE OKEECHOBEE STUDY AREA

which extends from June through September. Great variations in precipitation can occur within any particular year producing flooding in the summer months or drought in the winter and spring months under extreme conditions. There is some variation in areal distribution of rainfall in average conditions with the Everglades Agricultural Area receiving 6 inches of rainfall more than the areas surrounding the lake to the north and west.

TABLE I

RAINFALL - 30-YEAR HISTORICAL AVERAGE (INCHES)

	Lower Kissimmee Valley	Lake Okeechobee	Everglades Agricultural Area
January	1.99	1.84	1.94
February	2.44	2.20	2.02
March	3.12	2.98	3.13
April	2.81	2.76	2.93
May	3.88	4.03	4.74
June	8.27	8.11	8.83
July	7.41	6.89	8.16
August	6.85	6.77	7.82
September	7.26	7.19	8.52
October	4.48	4.68	5.59
November	1.54	1.37	1.66
December	1.60	1.54	1.74
TOTAL	51.65	50.36	57.08

Land Use/Land Cover

An analysis of land use/land cover was conducted by the District's Land Resources Division resulting in an up-to-date (1979-81) series of maps reflecting the natural and man-made features and characteristics of each basin tributary to Lake Okeechobee. The maps reflect the areal distribution of the land uses and land covers within each basin. The dominant land uses become evident as they are broken down in table form to reflect the number of acres. North of the lake, improved pasture is the dominant land use. Vegetables and sugarcane are the primary agricultural crops in the S-2 and S-3 Basins, while the S-4 Basin is approximately one-half improved pasture and one-half sugarcane. It is noteworthy that natural areas constitute a significant percentage of the C-38, Fisheating Creek, and S-71 watersheds.

The following summary table gives an accounting, in acres, of the land uses and land covers within each basin. A detailed accounting of land uses and land covers by basin can be found in Appendix I . The basins can be located geographically on the map in Figure I.

B. Goals and Guidelines

Water quantity impacts on the water resources within the District are at least as important as water quality impacts. The primary goals of the District have historically been to minimize flooding during periods of excess rainfall and to maximize water supply storage. Now a third major goal of equal importance is proposed; namely, to maintain and improve the quality of the water resources within the District. Development and implementation of a water quality management strategy for Lake Okeechobee would be a major step toward achieving that goal. For Lake Okeechobee, then, the primary water resource goals are as follows:

...minimize the impacts of flooding during periods of excess rainfall,

...maximize water supply storage, and

...improve the water quality of Lake Okeechobee.

These goals were used to guide staff during the process of developing a long-range strategy for managing Lake Okeechobee.

Based upon the primary goals, above, certain guidelines evolved during the study deliberations. These guidelines enabled staff to develop and evaluate a range of technical alternatives from both quantitative and qualitative standpoints. The specific guidelines used were as follows:

...Technical Publication 81-2 (Lake Okeechobee Water Quality Studies and Eutrophication Assessment) was used as the technical foundation for determining water quality limitations for Lake Okeechobee. Specifically, the objective is to reduce nutrient loadings presently entering Lake Okeechobee to acceptable levels.

...No selected alternative will contain diversion or removal of water to tide from Lake Okeechobee or its tributary areas.

...Losses of water from storage in the Lake Okeechobee tributary system resulting from the application of selected alternatives shall be minimized to the extent possible.

...Cost-effectiveness (cost per amount of nutrient removed from Lake Okeechobee) shall be used as the major criterion for ranking the various alternatives.

...Flood protection provided by existing surface water management systems will not be reduced.

...Environmental, economic, land use, and institutional impacts will be considered in selecting the preferred alternative(s).

TABLE 2

SUMMARY TABLE OF LAND USES IN BASINS TRIBUTARY TO LAKE OKEECHOBEE

Basin	Low Intensity Urban	High Intensity Urban	Truck Crops, Sod Farms	Sugar Cane	Citrus	Dairy Farms, Feedlots	Improved Pasture	Uplands	Wetlands
S-2	2,471	1,156	3,936	96,621	19	0	1,146	0	0
S-3	245	14	3,030	57,380	0	0	3,773	0	0
S-4	2,291	601	238	17,123	0	206	19,831	0	1,517
East Beach D.D.	709	148	169	4,312	0	0	0	0	0
715 Farms	278	0	0	2,924	0	0	0	0	0
East Shore D.D.	0	0	0	8,457	0	0	0	0	0
South Shore D.D.	368	9	0	2,522	0	0	0	0	0
S-236	244	31	56	8,243	0	0	1,997	0	0
F.E. Creek	2,007	15	29	0	3,508	56	80,280	156,726	52,646
S-127	569	0	0	0	0	20	17,575	144	1,998
S-129	334	0	0	0	0	0	11,333	50	0
S-131	363	0	0	0	0	0	6,376	84	14
S-71	2,392	22	1,575	0	8,812	27	56,871	29,615	2,582
S-72	53	4	337	0	2,689	0	37,754	9,839	4,473
S-84	10	0	0	0	0	0	19,243	30,814	6,558
Lower Kiss.	99	0	0	0	0	88	8,657	720	2,689

TABLE 2 (CONTINUED)

SUMMARY TABLE OF LAND USES IN BASINS TRIBUTARY TO LAKE OKEECHOBEE (CONTINUED)

Basin	Low Intensity Urban	High Intensity Urban	Truck Crops, Sod Farms	Sugar Cane	Citrus	Dairy Farms, Feedlots	Improved Pasture	Uplands	Wetlands
S-154	2,457	318	0	0	0	65	18,493	1,564	455
L.T. Ck. S-133	4,551	1,157	4	0	162	0	15,600	2,004	910
U.T. Ck. Nubbin Slough	3,441	315	444	0	1,804	31,458	51,327	15,128	16,335
S-135	333	7	0	4,507	61	15	9,168	1,781	754
S-65A	351	107	2,491	0	1,179	42	42,608	47,559	7,576
S-65B	1,919	0	2,316	0	481	0	20,965	81,985	18,373
S-65C	12	0	0	0	0	19	31,025	11,609	5,923
S-65D	269	0	672	0	175	104	71,616	33,124	8,628
S-65E	480	7	621	0	3	37	26,586	8,673	1,183
TOTAL	22,149	3,911	43,191	202,089	18,893	1,207	583,154	431,419	132,614

II. ANALYSIS OF TRIBUTARIES AND NUTRIENT SOURCES

A. Watershed Ranking

District Technical Publication #81-2 provides the technical foundation for determining a systematic, reasonable long-range strategy for managing nutrient inputs to Lake Okeechobee. This report was accepted by the Governing Board in May 1981.

As stated in Technical Publication #81-2, application of the modified Vollenweider model to Lake Okeechobee indicates that in order to meet the excessive loading rates for total phosphorous and total nitrogen, overall reductions of 40 percent and 34 percent in the average annual loadings of total phosphorous and total nitrogen, respectively, must be accomplished. Several assumptions were employed in calculating load allocations and are itemized below:

Other Sources

The three sources that were included in this category were: direct rainfall on Lake Okeechobee, the area north of and including Lake Kissimmee which discharges through S-65, and the area north of and including Lake Istokpoga, which discharges through S-68. Rainfall was considered a "non-controllable" nutrient source in terms of this evaluation. Further, the Upper Kissimmee Chain of Lakes and Lake Istokpoga were considered as receiving waters themselves. This distinction was made because at some point in the future these lakes will be subject to their own set of water quality limitations. Thus, the total loadings to Lake Okeechobee were corrected as depicted below.

	Discharge (acre-feet)	TP (tons)	TN (tons)
Rainfall	1,350,393	111	2,004
S-65 Basins	484,523	27	1,030
S-68 Basins	180,469	15	309
Total, Other Sources	2,015,385	153	3,343

1. S-65E

In previous allocation calculations and in Technical Publication #81-2, the S-65E basin extended from S-65E to the City of Orlando. Since the Upper Kissimmee Lakes Basin has now been classified as "other," the material load at S-65E needs to be corrected for the discharge from the Upper Kissimmee lakes, which discharges through S-65. Therefore, the mean annual discharge and N and P loads at S-65 (Ref. - Water Quality Characteristics of the Lower Kissimmee River 1973 to 1978, Technical Publication 82-3, May 1982) were subtracted from the mean annual load at S-65E as published in Technical Publication #81-2.

	Kissimmee Basin	- S65	= S65E
Total P	135	27	108 tons
Total N	2,027	1,030	997 tons
Discharge	1,073,849	484,523	589,326 acre-feet

2. S-71, S-72, and S-84

The material load discharged through S-68 from Lake Istokpoga was estimated by multiplying the mean annual discharge from water year 1973 to 1979 at S-68 (USGS Water Resources data) by the mean annual N and P inlake concentration. The inlake concentration was calculated by averaging the mean concentration measured by FDER (1979) from 1974 to 1978 and the mean concentration measured by Milleson (1978) from 1973 to 1976. The loads through S-68 were, therefore, calculated by the following equation:

Total N load = 180,469 acre-feet/yr. x 1.26 mg N/L = 309.3 tons N

Total P load = 180,469 acre-feet/yr. x 0.06 mg P/L = 14.8 tons P

Since the discharge at S-68 can ultimately pass through either S-71, S-72, or S-84, the load at S-68 needed to be proportioned among these three structures. The assumption was made that the discharge from S-68 was divided among S-71, S-72, and S-84 in proportion to the amount of water these three structures discharged into the lake. Of the 347,893 acre-feet/yr. discharged by S-71, S-72, and S-84, 49 percent was contributed by S-71, 11 percent by S-72, and 40 percent by S-84.

These percent contributions were multiplied by the annual load from S-68 and subsequently subtracted from each respective structure:

S-71

Total P (tons)	54.5 - (.49 x 14.8)	47.2 tons
Total N (tons)	474.2 - (.49 x 309.3)	322.6 tons
Discharge (acre-feet)	169,838 - (.49 x 180,469) =	81,408 acre-feet

S-72

Total P (tons)	10.0 - (.11 x 14.8) =	8.4 tons
Total N (tons)	119.7 - (.11 x 309.3) =	85.7 tons
Discharge (acre-feet)	37,425 - (.11 x 180,469) =	17,573 acre-feet

S-84

Total P (tons)	11.5 - (.40 x 14.8)	=	5.6 tons
Total N (tons)	233.8 - (.40 x 309.3)	=	110.1 tons
Discharge (acre-feet)	140,630 - (.40 x 180,469)	=	68,442 acre-feet

Two approaches were then taken to rank the contributing watersheds in terms of excessive total P and total N loading. One approach ranked them according to drainage area, which was accomplished by applying a uniform, allowable loading rate for total P and total N per amount of area drained, and comparing this to the actual amounts of total P and total N discharged from each watershed (see Tables 3 and 4). For example, the excessive loading rates were 0.11 tons/mi^2 drained/year for total P, and 0.94 tons/mi^2 drained/year for total N. Application of this loading rate to Taylor Creek/Nubbin Slough (S-191) shows that the desired load from S-191 should be 21 tons/year total P and 177 tons/year total N, whereas the actual loads were 189 tons/year total P and 479 tons/year total N.

Similar calculations were performed for each watershed to determine how much the actual loads exceeded the desired loads. The watersheds were then ranked according to the amount of excess total P and total N loads combined with the percentage of the total load for total P and total N contributed by that watershed.

The second approach was similar, except annual discharge rather than drainage area was used to make the load allocations. Desired loading rates based on annual discharge are 0.33 lbs. total P/AF/year and 2.9 lbs. total N/AF/year (see Tables 5 and 6).

The results of both rankings are given in Tables 7 and 8 . It is important to point out that the two highest ranked watersheds, S-191 and S-2, are ranked in the same positions for both approaches and that the top seven watersheds are the same for both approaches. Desired reductions for total P and total N are given for each of these seven major watersheds. Implementation of management actions in these watersheds to achieve the desired load reductions for each would result in meeting the total overall required reductions of 40 percent total P and 34 percent total N. Further, it is significant to note that with implementation of actions in the Taylor Creek/ Nubbin Slough Basin (S-191) and the EAA (S-2 and S-3) to achieve the indicated load reductions in each area, approximately 70 percent of the required total overall reductions would be accomplished. Finally, Table 9 provides both the priority watersheds for implementation of management actions and the target load reductions required for each priority watershed. These items are critical in evaluating proposed management actions and in laying out the strategy for implementation of these actions.

B. External Nutrient Sources

With the identification of the seven most significant contributing watersheds, the next step toward developing long-term solutions was to examine the nutrient sources within each watershed. Based on land use loading rates from

TABLE 3
PHOSPHORUS LOAD ALLOCATIONS FOR LAKE OKEECHOBEE BASED UPON DRAINAGE BASIN AREA

	Drainage Basin Area (sq. mi.)	Current Avg. Load (tons)		Allocation to Meet Excessive Loading Rate (tons)1/	Excess Above Excessive Allocation (tons)1/	% Excess	Rank7/	
Other sources2/		153						
C-383/	684	108	(21.5)6/	75	33	31%	2	(667)
S-2	166	35	(7.0)	18	17	49%	4	(343)
S-3	101	7	(1.4)	11	-4	--	10	(--)
S-4	66	15	(3.0)	7	8	53%	6	(159)
S-191	188	189	(37.6)	21	168	89%	1	(3346)
S-714/	176	47	(9.4)	19	28	60%	3	(564)
S-724/	87	8	(1.6)	10	-2	--	10	(--)
S-844/	180	6	(1.2)	20	-14	--	10	(--)
Fisheating Creek	462	65	(12.9)	51	14	22%	5	(284)
S-127	32	7	(1.4)	4	3	43%	7	(60)
S-129	19	3	(0.6)	2	1	33%	8	(20)
S-131	11	1	(0.2)	1	0	0	9	(0)
S-133	40	7	(1.4)	4	3	43%	7	(60)
S-135	28	4	(0.8)	3	1	25%	8	(20)
	2,240	5025/		246				

1/Excessive loading rate based upon modified Vollenweider (1976) model (South Florida Water Management District Tech. Pub. #81-2)

2/Other sources includes direct rainfall on Lake Okeechobee, Upper Kissimmee Lakes discharge through S-65 and discharge from from Lake Istokpoga through S-68

3/Includes area between S-65 and S-65E excluding discharge through S-65

$$\text{Phosphorus load allocation} = \frac{\text{Excessive loading rate} - \text{Other sources}}{\text{Drainage area of controllable sources}} = \frac{397 - 153}{2240} = 0.11 \text{ tons/sq. mi. drained}$$

4/Corrected for discharge through S-68 5/Total controllable load 6/Percentage of total controllable load

7/Based on (% Excess)(% of Total Controllable Load)

TABLE 4

NITROGEN LOAD ALLOCATIONS FOR LAKE OKEECHOBEE BASED UPON DRAINAGE BASIN AREA

	Drainage Basin Area (sq. mi.)	Current Avg. Load (tons)		Allocation to Meet Excessive Loading Rate (tons)1/	Excess Above Excessive Allocation (tons)1/	% Excess	Rank7/	
Other sources2/		3,343						
C-383/	684	997	(20.7)5/	643	354	36%	2	(745)
S-2	166	1,548	(32.2)	156	1,392	90%	1	(2898)
S-3	101	373	(7.8)	95	278	75%	4	(585)
S-4	66	142	(3.0)	62	80	56%	7	(168)
S-191	188	479	(10.0)	177	302	63%	3	(630)
S-71	176	323	(6.7)	165	158	49%	5	(328)
S-72	87	86	(1.8)	82	4	5%	10	(9)
S-84	180	110	(2.3)	169	-59	--	14	(--)
Fisheating Creek	462	575	(12.0)	434	141	25%	6	(300)
S-127	32	34	(0.7)	30	4	12%	11	(8)
S-129	19	33	(0.7)	18	15	45%	9	(32)
S-131	11	13	(0.3)	10	3	23%	12	(7)
S-133	40	41	(0.9)	38	3	7%	13	(6)
S-135	28	51	(1.1)	26	25	49%	8	(54)
	2,240	4,8054/		2,105				

1/Excessive loading rate based upon modified Vollenweider (1976) model (South Florida Water Management District Tech. Pub. #81-2)

2/Other sources includes direct rainfall on Lake Okeechobee, Upper Kissimmee Lakes discharge through S-65 and discharge from Lake Istokpoga through S-68

3/Includes area between S-65 and S-65E excluding discharge through S-65

$$\text{Nitrogen load allocation} = \frac{\text{Excessive loading rate - Other sources}}{\text{Drainage area of controllable sources}} = \frac{5452 - 3343}{2240} = 0.94 \text{ tons N/sq. mi. drained}$$

4/Total controllable load

5/Percentage of total controllable load

6/Based on (% Excess)(% of Total Controllable Load)

TABLE 5
PHOSPHORUS LOAD ALLOCATIONS FOR LAKE OKEECHOBEE BASED UPON ANNUAL DISCHARGE

	Mean Annual Discharge (acre-feet)	Current Avg. Load (tons)	Allocation to Meet Excessive Loading Rate (tons)1/	Excess Above Excessive Allocation (tons)1/	% Excess	Rank5/
Other sources2/		153				
C-38	589,326	108 (21.5)4/	98	10	9%	4 (194)
S-2	195,880	35 (7.0)	33	2	6%	9 (42)
S-3	55,733	7 (1.4)	9	-2	--	12 (--)
S-4	34,887	15 (3.0)	6	9	60%	5 (180)
S-191	153,586	189 (37.6)	26	163	86%	1 (3234)
S-71	81,408	47 (9.4)	14	33	70%	2 (658)
S-72	17,573	8 (1.6)	3	5	63%	6 (101)
S-84	68,442	6 (1.2)	11	-5	--	12 (--)
Fisheating Creek	203,449	65 (12.9)	34	31	48%	3 (619)
S-127	10,886	7 (1.4)	2	5	71%	7 (99)
S-129	11,168	3 (0.6)	2	1	33%	10 (20)
S-131	5,277	1 (0.2)	1	0	0	11 (0)
S-133	15,680	7 (1.4)	3	4	57%	8 (80)
S-135	17,432	4 (0.8)	3	1	25%	10 (20)
	1,460,727	502	245			

1/Excessive loading rate based upon modified Vollenweider (1976) model (South Florida Water Management District Tech. Pub. #81-2)

2/Other sources includes direct rainfall on Lake Okeechobee, Upper Kissimmee Lakes discharge through S-65 and discharge from Lake Istokpoga through S-68

3/Includes area between S-65 and S-65E excluding discharge through S-65

$$\text{Phosphorus load allocation} = \frac{\text{Excessive loading rate - Other sources}}{\text{Total annual discharge into Lake Okeechobee from controllable sources}} = \frac{397 - 153}{1,460,727} = \frac{.33\text{ lbs P}}{\text{acre-feet}}$$

4/Percentage of total controllable load

5/Based on (% Excess)(% of Total Controllable Load)

TABLE 6

NITROGEN LOAD ALLOCATIONS FOR LAKE OKEECHOBEE BASED UPON ANNUAL DISCHARGE

	Mean Annual Discharge (acre-feet)	Current Avg. Load (tons)	Allocation to Meet Excessive Loading Rate (tons)1/	Excess Above Excessive Allocation (tons)1/	% Excess	Rank5/
Other sources2/		3,343				
C-383/	589,326	997 (20.7)4/	851	146	15%	6 (311)
S-2	195,880	1,548 (32.2)	283	1,265	82%	1 (2640)
S-3	55,733	373 (7.8)	80	293	79%	2 (616)
S-4	34,887	142 (3.0)	50	92	65%	7 (195)
S-191	153,586	479 (10.0)	222	257	54%	4 (540)
S-71	81,408	323 (6.7)	118	205	63%	5 (422)
S-72	17,573	86 (1.8)	25	61	71%	8 (128)
S-84	68,442	110 (2.3)	99	11	10%	13 (23)
Fisheating Creek	203,449	575 (12.0)	294	281	49%	3 (588)
S-127	10,886	34 (0.7)	16	18	53%	11 (37)
S-129	11,168	33 (0.7)	16	17	52%	12 (36)
S-131	5,277	13 (0.3)	8	5	38%	14 (11)
S-133	15,680	41 (0.9)	23	18	44%	10 (40)
S-135	17,432	51 (1.1)	25	26	51%	9 (56)
	1,460,727	4,805	2,110			

1/Excessive loading rate based upon modified Vollenweider (1976) model (South Florida Water Management District Tech. Pub. #81-2)

2/Other sources includes direct rainfall on Lake Okeechobee, Upper Kissimmee Lakes discharge through S-65 and discharge from Lake Istokpoga through S-68

3/Includes area between S-65 and S-65E excluding discharge through S-65

$$\text{Nitrogen load allocation} = \frac{\text{Excessive loading rate} - \text{Other sources}}{\text{Total annual discharge into Lake Okeechobee from controllable sources}} = \frac{5452 - 3343}{1,460,727} = 2.9 \text{ lbs N per acre-foot discharged}$$

4/Percentage of Total Controllable Load

5/Based on (% Excess)(% of Total Controllable Load)

TABLE 7

Overall Watershed Ranking

Based Upon Drainage Area Allocation

Watershed	Total P Factor	Total N Factor	Combined Total P & N	Rank
S-191	3346	630	3976	1
S-2	343	2898	3241	2
C-38	667	745	1412	3
S-71	564	328	892	4
S-3	-	585	585	5
Fisheating Creek	284	300	584	6
S-4	159	168	327	7
S-135	20	54	74	8
S-127	60	8	68	9
S-133	60	6	66	10
S-129	20	32	52	11
S-72	-	9	9	12
S-131	0	7	7	13
S-84	-	-	-	14

TABLE 8

Overall Watershed Ranking Based

Upon Annual Discharge Allocation

Watershed	Total P Factor	Total N Factor	Combined Total P & N	Rank
S-191	3234	540	3774	1
S-2	42	2640	2682	2
Fisheating Creek	619	588	1207	3
S-71	658	422	1080	4
S-3	-	616	616	5
C-38	194	311	505	6
S-4	180	195	375	7
S-72	101	128	229	8
S-127	99	37	136	9
S-133	80	40	120	10
S-135	20	56	76	11
S-129	20	36	56	12
S-84	-	23	23	13
S-131	0	11	11	14

TABLE 9

DESIRED LOAD REDUCTIONS FOR PRIORITY WATERSHEDS

Watershed	Rank	Desired Total P Reduction (Tons)		Desired Total N Reduction (Tons)	
Taylor Creek/Nubbin Slough (S-191)	1[1](1)[2]	168[1]	(163)[2]	302[1]	(257)[2]
S-2	2(2)	17	(2)	1392	(1265)
Kissimmee River (C-38)	3(6)	33	(10)	354	(146)
Fisheating Creek	6(3)	14	(31)	141	(281)
Harney Pond (S-71)	4(4)	28	(33)	158	(205)
S-3	5(5)	--	(--)	278	(293)
S-4	7(7)	8	(9)	80	(92)
TOTALS		268	(248)	2705	(2539)
TOTAL OVERALL DESIRED REDUCTIONS		256		2700	

[1]Figures in first columns based on drainage area allocation

[2]Figures in second columns based on annual discharge allocation

previous and on-going studies (see Table 10) and land use/land cover data developed by the Land Resources Division, average annual loadings for various land uses were calculated for each watershed. Further, DER records were researched to identify point source discharges in each area, such as municipal and industrial wastewater treatment plants. Table 11 provides a summary of that analysis for the seven priority watersheds. It is not surprising that north of the lake, improved pasture is the dominant land use and contributes the majority of the total P and total N loads from those watersheds. The exception is the Taylor Creek/Nubbin Slough watershed where intense dairy operations contribute the largest loadings of total P and total N. In the EAA, sugarcane is the primary land use and in conjunction with soil type, contributes the major portions of total P and total N loads. The exception is the S-4 basin, which is approximately one-half improved pasture and one-half sugarcane. It is also noteworthy that natural areas constitute a significant percentage (in excess of 1/3) of the C-38, Fisheating Creek, and S-71 watersheds. This serves as a reasonable explanation, as indicated in Table 12, for the differences between the calculated and measured nutrient loads for these watersheds. Essentially, the natural areas appear to be assimilating a portion of the nutrient loads coming from the more intense land uses such as improved pasture. Further, it should be recognized that the calculated loadings may be low in certain basins (particularly the northern basins) because the loading coefficients for pasture and dairy operations were calculated from data collected during an abnormally dry period. Finally, point source discharges in the S-2 basins are significant sources of total phosphorous in that basin. Detailed calculations and results for each priority watershed are presented in Appendix I.

TABLE 10

LOADING COEFFICIENTS FOR VARIOUS LAND USE TYPES

Land Use	Total P lb/ac/yr	Total N lb/ac/yr
Low intensity urban[1]	1.6	5.9
High intensity urban[1]	2.4	12.0
Truck crops, sod farms[2]	1.9	33.2
Sugarcane[2]	0.6	24.2
Citrus[1]	0.2	4.0
Dairy farms[3]		
Intensely managed areas	15.3	38.7
Upland pasture	4.2	9.0
Cattle feedlots[3]	15.3	38.7
Improved pasture (beef cattle)		
Northern basins[4]	1.2	4.5
S-2 and S-3 basins[2]	0.5	9.2
S-4 basin[4]	1.2	4.5
Uplands[4]	0.05	1.1
Wetlands[1]	0.18	4.9
Wastewater treatment plant[5]	7.0 mg/l	20.0 mg/l
Lake Okeechobee load allocation[6]	0.34	2.9

[1]Wanielista

[2]CH_2M-Hill

[3]SFWMD Uplands Demonstration Projects

[4]Average of SFWMD and Wanielista's data

[5]Plant operation reports

[6]Calculated from Tables 3 and 4

TABLE II

PERCENTAGE SUMMARY OF LAND USE/LOADING ANALYSIS

FOR MAJOR LAKE OKEECHOBEE TRIBUTARIES

Watershed	Dominant Sources	% of Watershed Land Area	% of Total P Load	% of Total N Load
S-191	Dairy, Feedlots	26.2	73.4	56.3
	Improved Pasture	42.3	23.2	29.9
	Urban	23.2	1.9	2.4
	Wetlands	13.6	0.9	7.8
S-2	Sugarcane	91.7	50.2	88.9
	Point Sources	--	36.9	4.6
	Crops, Sod	3.7	6.5	4.5
	Urban	3.5	5.9	1.1
C-38 (S-65A, B, C, D & E)	Improved Pasture	45.0	89.3	64.5
	Crops, Sod	1.4	3.6	11.3
	Uplands	42.7	2.8	11.2
	Wetlands	9.7	2.3	11.4
	Urban	0.7	1.6	1.1

TABLE II (CONTINUED)

PERCENTAGE SUMMARY OF LAND USE/LOADING ANALYSIS

FOR MAJOR LAKE OKEECHOBEE TRIBUTARIES

Watershed	Dominant Sources	% of Watershed Land Area	% of Total P Load	% of Total N Load
S-71	Improved Pasture	51.0	90.1	72.8
	Urban	2.2	4.1	3.1
	Citrus	9.3	2.2	8.9
	Uplands	34.7	2.0	9.1
	Crops, Sod	0.4	0.9	3.3
	Wetlands	2.3	0.5	2.7
S-3	Sugarcane	89.0	81.0	91.0
	Crops, Sod	4.7	13.5	6.6
	Improved Pasture	5.9	4.4	2.3
Fisheating Creek	Improved Pasture	27.2	84.9	51.3
	Wetlands	17.8	6.7	25.5
	Uplands	53.0	5.5	18.4
	Urban	0.7	2.3	1.3
	Citrus	1.2	0.5	1.5

TABLE II (CONTINUED)

PERCENTAGE SUMMARY OF LAND USE/LOADING ANALYSIS

FOR MAJOR LAKE OKEECHOBEE TRIBUTARIES

Watershed	Dominant Sources	& of Watershed Land Area	% of Total P Load	% of Total N Load
S-4	Improved Pasture	47.4	63.7	20.8
	Sugarcane	40.9	21.9	72.6
	Urban	6.9	10.9	3.6

TABLE 12

COMPARISON OF CALCULATED VS. MEASURED MAJOR TRIBUTARY LOADS

Tributary	Flow AF/mi^2-yr	Total P, Tons/yr		Total N, Tons/yr	
		Calculated	Measured	Calculated	Measured
S-191	817	166	189	516	479
S-2	1,180	58	35	1,315	1,548
C-38	862	162	108	897	997
Fisheating Creek	440	71	65	469	575
S-71	463	47	47	234	323
S-3[1]	552 (1,104)	21 (11)	7	763 (382)	373
S-4[1]	529 (1,058)	23 (12)	15	285 (142)	142

[1] The data indicate that approximately ½ of the flow (and consequently ½ of the total P and total N loadings) is directed toward one or more outlets other than S-3 and S-4. Adjusting for this circumstance results in the loadings in parentheses, which show good agreement with the empirical data.

III. NUTRIENT LOAD REDUCTION ALTERNATIVES

A. Methods of Analysis

1. Description of Conceptual Approaches

There are four basic approaches to analyze the technical alternatives in the Lake Okeechobee area which could be used to reduce the nutrient loads to the lake. They are as follows:

Approach #1, runoff storage

For analysis purposes, storage will be interpreted as detention of runoff from the surface water system which contributes to Lake Okeechobee for a certain duration of time before releasing back into the lake. The categories of runoff storage will include 1) regional storage in each major tributary area, 2) sub-regional storage, 3) on-site detention of runoff. The degree of treatment for nutrient runoff will be based on certain percentages of flow to be detained or treated, and the on-site detention of runoff will consider detaining the first inch of runoff from each individual system.

Approach #2, runoff diversion

Divert as much as practical of the high nutrient flows to other areas where the water quality impacts would not be as severe. Diversion could only be practical in three of the five major tributary areas; namely, the Taylor Creek/Nubbin Slough basin, the EAA, and Fisheating Creek.

Approach #3, on-the-farm practices

This category includes those practices listed in Table 13. This approach is heavily dependent upon data availability and land use type, and the practices listed are still experimental in nature. For these reasons, a detailed evaluation of both cost and nutrient treatment efficiencies for these BMPs in comparison with other approaches could not be accomplished. However, these practices will not be deleted from consideration because they are experimental, and numerous research/demonstration projects are currently underway to provide better documentation of costs and nutrient removal efficiencies. An extensive list of references is provided in Appendix II.

Approach #4, conventional or reverse osmosis (R/O) treatment

This approach would involve the construction of one or more conventional or reverse osmosis treatment plants at selected inflow points to Lake Okeechobee.

2. Basis for Cost Estimates

a. Regional and sub-regional storage

Cost estimates for the proposed facilities were based on the latest available information obtained by staff. The December 1980 cost index presented in the Engineering News Record was applied to update

TABLE 13

POTENTIAL BEST MANAGEMENT PRACTICES (BMPs)

(1) Treatment of barn, feedlot, and holding area stormwater runoff through use of oxidation/polishing lagoons.

(2) Improved fertilizer management, by use of soil testing and plant analysis to avoid overapplication of fertilizer; timing and placement of fertilizers to maximize plant uptake.

(3) Biological nutrient removal - use of vegetated swales, ditches, and/or shallow grassed waterways.

(4) Dragging pastures, redistribution of barn and feedlot waste to pasture areas.

(5) Improved pasture management, by rotating grazing areas and periodically changing vegetative cover.

(6) Fencing of waterways, in conjunction with appropriate placement of salt, mineral, feed supplement, shaded area, and watering trough and tank sites away from waterways.

(7) Conversion of barn and feedlot waste to methane gas for local use.

(8) Biological nutrient removal - use of water hyacinths in temporary runoff storage lagoons for nutrient uptake.

(9) Recycling of barnwash and holding area runoff.

costs as necessary. Costs of channel excavation, levee construction, and levee "coring" were estimated as $2.00 per cubic yard, $3.50 per cubic yard, and $5.00 per linear foot, respectively. The construction costs for pumping stations was based on the bid information for S-331 and S-319, and previous District reports. However, if the pumping capacity was less than 150 cfs, then a value of $3.50 per gallon per minute was used. The construction cost for gated spillway structures was based on the bid information for S-155, S-159, S-333, S-335, and S-155A, then a best fit curve was developed for the estimation of the construction cost for various spillway structure capacities. The construction cost for highway bridges was based on $3,000 per foot of length of two lane highway. These costs can vary considerably according to the location of construction and material requirements, but the costs above are considered reasonable.

b. On-site storage

Since it would be extremely difficult and time consuming to design an on-site storage system for each specific parcel of land in Lake Okeechobee's tributary area, a more generalized approach was taken to develop a first-cut estimate of costs for on-site runoff. This first-cut cost estimate will be used as a good first estimate of cost for implementing best management practices on-site in comparison with other more regional approaches. The cost estimate is probably conservative since experience to date indicates that installation of BMP's will more than likely result in a significantly lesser expenditure. Due to topography, land use, and the type of primary canal systems (generally, gravity drainage systems north of the lake and pumped drainage systems south of the lake in the EAA) in existence, the types of on-site storage system designs required will be different north of the lake from those in the EAA. Figure 2 shows an example layout for an on-site storage area in the EAA. The storage area would have to be excavated to a depth of 2.75' below the natural ground elevation and would be bordered on three sides by a levee with a 5' top width (approximately one foot of freeboard over normal storage depth). Land requirements for the storage area would be approximately 3 percent of the parcel drainage area for detaining the first inch of runoff. Costs for excavation and levee construction would be the same as in a., above, since the type of construction equipment used would probably be the same.

In the tributary areas north of Lake Okeechobee, the stormwater management systems are primarily gravity in nature due to the topography. Secondly, improved pasture is the major land use north of the lake. Based on these considerations, a different type of on-site storage can be utilized for individual drainage systems in this area, an example of which is depicted in Figure 3.

Essentially, this option would require constructing a low level berm approximately 4-5' high across the outlet point of each drainage system. The berm would be constructed from material excavated upstream of the berm using a bulldozer; thus the excavated area would also provide for runoff storage. An underdrain system would be placed in the berm to promote filtration of the runoff prior to discharge downstream. The berm would be limed and planted with a cover crop to promote uptake of phosphorous and nitrogen and would be fenced to keep cattle off the berm. A cover crop of pangola/clover or other suitable cover crop would be planted in the excavated area to provide additional nutrient uptake. The required length of berm and the amount of excavated area will vary for each individual drainage system because of topography, type of drainage system, and other factors. Therefore, a conservative approach to estimate the cost of this option was developed based on excavating an area sufficient to store the first one inch of runoff from the property in question or excavating approximately 1/12 of the property. In terms of cost, excavation and berming using a bulldozer was estimated to cost $\$1.00/yd^3$, planting the cover crop at \$150/acre and remaining costs at 10 percent of the excavation costs (includes fencing of berm, liming, underdrain system, outlet controls, etc.).

c. Runoff diversion

Unit costs for these options were taken as the same as listed in a., above.

d. Conventional and reverse osmosis (R/O) treatment plants

Based on previous work in support of the District's water use planning efforts, cost equations for reverse osmosis treatment plants and pretreatment were updated to mid-1980 to be used in this evaluation. The two costs equations are as follows:

R/O plant

$$\text{Capital cost, \$} = 196{,}650 + 1{,}166{,}790\ Q^{0.988}$$

Pre-treatment (filtration)

$$\text{Capital cost, \$} = 609{,}350\ Q^{0.72}$$

where Q = product water quantity in MGD.

In terms of conventional treatment plants, treatment processes specifically designed for phosphorous or nitrogen removal were examined.

The nitrogen "treatment train" consisted of conventional secondary treatment with an extended aeration-denitrification process at the end of the train. For phosphorous removal, the "treatment train" was composed of chemical coagulation (ferric chloride), flocculation, sedimentation, and filtration. Capital costs for these processes were determined using EPA construction cost indices (1972), which were updated to mid-1980 to correct for inflation. Costs for various sized plants were as listed below.

Plant Size, MGD	Process (P or N removal)	Cost ($ Million)
100	P	106
35	N	38
50	N	52
100	N	96

3. Basis for Nutrient Load Reduction Calculations

a. Regional and sub-regional storage options

There are two primary considerations in calculating the amount of nutrients removed on an average annual basis from Lake Okeechobee. First, it was assumed that the concentrations of total phosphorous and total nitrogen remained the same for each inflow point, regardless of the amount of flow (flow-weighted concentrations were used). Thus, the loads of total phosphorous and total nitrogen diverted to storage were calculated by multiplying the fraction of flow diverted times the total average annual load contributed to the lake by the specific inflow point. The second consideration is the degree of treatment provided by the storage areas. Based on an extensive literature survey (see Appendix II), it was decided that a nutrient removal efficiency range of 30 percent-50 percent on an average annual basis for both total phosphorous and total nitrogen should be used to determine average annual load reductions. The loads released back into Lake Okeechobee, then, were calculated to be reduced by 30 percent-50 percent on an average annual basis of those loads diverted to detention storage.

b. On-site storage

Due to the two different types of on-site storage designs required, as described earlier, two different treatment efficiencies were used to determine nutrient load reductions. In the EAA, since a conventional storage area like in a., above, is proposed for individual drainage systems (smaller scale, of course), a 30 percent-50 percent nutrient removal efficiency range was used.

For those on-site systems north of the lake (improved pasture operations), a berm filtration/storage technique would be used. It is estimated this type of system would provide treatment efficiencies of 90 percent for total P and 80 percent total N on an average annual basis.[1]

Basically, the load reduction (either total P or total N) at the inflow point to Lake Okeechobee can be calculated using the following general relationship:

[1] Wanielista, personal communication

$$L_R = L_M - (N_T + N_O)$$

where L_R = load reduction at inflow point to Lake Okeechobee on an average annual basis

L_M = measured average annual load at inflow point to lake

N_T = load, after treatment, from land use being treated

N_O = total combined load from all other land uses not being treated.

Using this general relationship will provide a conservative estimate of the total load reduction from a particular watershed since no additional treatment by natural processes within the watershed are taken into account.

c. Runoff diversion

To calculate total P and total N load reductions for these options, the same procedure as in a., above, would apply, except that the runoff would be transferred to a receiving water other than Lake Okeechobee. Thus, the load reductions would be determined by multiplying the fraction of flow diverted times the total average annual load contributed to the lake by the specific inflow point.

d. Conventional and R/O treatment plants

Available literature (based on actual operating experience) was researched to determine total P and total N removal efficiencies for the selected treatment processes. The values used in the staff's analysis are listed below.

Type of Plant/Process	Total P Removal, %	Total N Removal, %
Reverse Osmosis (R/O)	90	90
Extended Aeration/Denitrification	40	70-90
Chemical Coagulation, Flocculation, Sedimentation, Filtration	95	50

Based on flow records for each inflow point, a determination was made regarding the amount of flow that could be treated on an average annual basis in each priority watershed. The nutrient load to be treated would then be the fraction of flow diverted for treatment multiplied by the average annual load for that particular inflow point to the lake.

B. Description of Alternatives for Priority Watersheds

1. Taylor Creek/Nubbin Slough Basin

a. Regional storage options

The proposed storage area is located between the FEC Railroad and State Road 710 (SR 710).

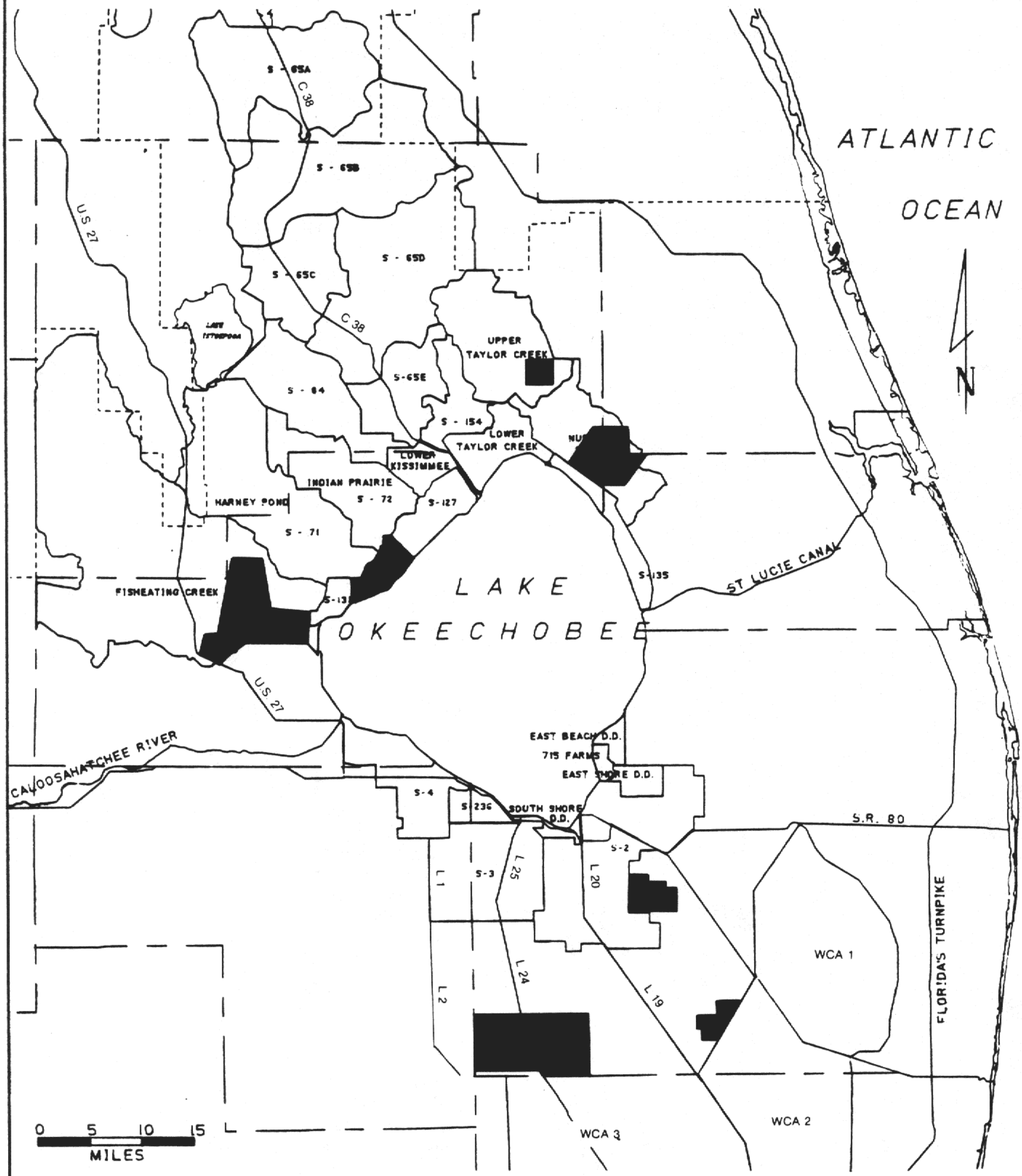


Figure 4 POTENTIAL RUNOFF STORAGE AREAS

(1) Divert 90 percent of the flow into the proposed reservoir. The routing results indicate a maximum stage of 37.2 ft. msl with average stage at 32.2 ft. msl, i.e., the maximum water depth in the reservoir will be 12.2 ft. with an average depth of 7.2 ft.

(a) Proposed facilities

This proposed regional reservoir will have a storage area of 16,700 acres and require 86,500 feet of levee and slurry cut-off wall for prevention of seepage. The proposed levee will have a 20 foot top width with 1V to 3H side slope and top elevation at 40.0 ft. msl. The system requires one 650 cfs pumping station to lift runoff from Taylor Creek/Nubbin Slough into the reservoir, and one 650 cfs gravity gated spillway to discharge water from the reservoir into a connecting canal between S-191 and the reservoir. Two new highway and railroad bridges would be needed.

(b) Capital cost

Land cost and canal R/W	$36,002,700
Levee	11,365,000
2-80' railroad bridges	1,180,000
2-80' highway bridges	480,000
Canal excavation	293,400
1-650 cfs pumping station	2,600,000
1-650 cfs gated spillway	750,000
TOTAL	$52,671,100

(2) Divert 50 percent of flow to regional storage area. The maximum routed stage is 34.4 ft. msl with an average stage of 31.3 ft. msl.

(a) Proposed facilities

The facilities for the system are about the same as for (1), above; however, only a 150 cfs pumping station is required. The outflow facility is one-84 inch cmp with a semi-circular lift gate.

(b) Capital cost

Land cost and canal R/W	$32,035,000
Levee	6,118,000
2-80' railroad bridges	1,180,000
2-80' highway bridges	480,000
Canal excavation	74,000
1-150 cfs pumping station at $3.50/gpm	240,000
1-150 cfs gated cmp culvert	140,000
TOTAL	$40,267,000

b. Sub-regional storage options

Two locations are considered, one of which is located between the FEC Railroad and SR 710, which is the same proposed location for regional storage. The second storage area is located about one mile east of SR 441 and one to two miles north of SR 70.

(1) Divert 90 percent of flow into sub-regional storage

(a) Nubbin Slough Basin

The routed stage based on the last eight years of record indicated that the maximum stage may reach 34.2 ft. msl with an average stage of 31.2 ft. msl. The storage area is about 16,700 acres.

i) The system requires one 250 cfs pumping station and one 250 cfs gated cmp culvert (one 84" culvert). The proposed levee is slightly lower than for the regional storage option and the same height as described for a.(2), above.

ii) Capital cost

Land cost and canal R/W	$32,035,000
Levee	4,118,000
2-80' railroad bridges	1,180,000
2-80' highway bridges	480,000
Canal excavation	122,000
1-250 cfs pumping station @ $3.50/gpm	393,000

1-84" CMP with semi-circular culvert	140,000
TOTAL	$40,468,000

(b) Upper Taylor Creek Basin

The routed stage based on the last 18 years of record indicated a maximum stage of 45.4 ft. msl with an average stage at 36.2 ft. msl. The required levee height will be at 50 ft. msl with a storage area of 6,000 acres.

i) Proposed facilities

The proposed levee for the reservoir would require 20 ft. width with 1V to 6H side slope. The system will require a one mile intake canal and a one mile long discharge canal to lift 650 cfs flow from Taylor Creek into the reservoir and discharge back to Taylor Creek at SR 70. The levee will require 66,000 ft. of slurry cut-off wall to reduce seepage through the levee.

ii) Capital cost

Land cost	$12,900,000
Canal R/W	78,200
Levee	18,074,000
Canal excavation	235,000
1-660 cfs pumping station	2,750,000
1-660 cfs gated spillway	650,000
Remove portion of existing railroad	30,000
TOTAL	$34,717,200

(2) Divert 50 percent of flow into sub-regional storage. The system requirements are about the same as the storage option for 90 percent flow, except the intake and outflow facilities are smaller in size.

(a) Nubbin Slough Basin

i) Proposed facilities

One-80 cfs pumping station and one 84" CMP gated culvert are required. The rest of the facilities are the same as the option to detain 90 percent flow.

ii) Capital cost

Land cost and canal R/W	$32,035,000
Levee	6,118,000
2-80 ft. railroad bridges	1,180,000
2-80 ft. highway bridges	480,000
Canal excavation	40,000
1-80 cfs pumping station @ $3.50/gpm	126,000
1-84" CMP gated culvert	140,000
TOTAL	$40,119,000

(b) Upper Taylor Creek Basin

The routed stage indicates a maximum stage of 42.5 ft. msl with average stage at 35.7 ft. msl. The storage area is 6,000 acres.

i) Proposed facilities

One 150 cfs pumping station and an intake canal are needed to lift runoff from Taylor Creek to the reservoir, and one 150 cfs 84" CMP gated culvert structure and discharge canal are required to release water back into Taylor Creek near SR 70. The proposed levee would require a 20 ft. top width at elevation 48.0 ft. msl with 1V on 6H side slope. Sixty-six thousand (66,000) ft. of slurry cut-off wall to reduce seepage are required.

ii) Capital cost

Land cost	$12,900,000
Canal R/W	78,200
Levee	18,074,000
Canal excavation	59,000
1-150 cfs pumping station @ $3.50/gpm	236,000
1-84" CMP gated culvert	140,000
Removed portion of existing railroad grade	30,000
TOTAL	$13,443,200

c. Diversion options

(1) Divert 90 percent of flow via L-63S, L-64, and L-65 borrow canals to the Florida Power and Light Reservoir; the excess water will be discharged into the St. Lucie Canal through S-153 by gravity.

(a) Proposed facilities

One-750 cfs pumping station would be required to lift the runoff from Taylor Creek/Nubbin Slough into the L-63S, L-64, and L-65 to deliver this water to the FP&L reservoir. The connection of this system to the FP&L reservoir would require a small channel from L-65 to a new pumping station to lift 200 cfs of water into the reservoir. This portion of the connection will require additional railroad and highway bridges at S.R. 710.

(b) Capital costs

One-750 cfs pumping station	$3,000,000
Excavation of R/W	2,655,700
FP&L connection:	
\$200 cfs pumping station & canal	984,000
Railroad bridge	590,000
S.R. 710 bridge	236,000
TOTAL	$7,465,700

(2) Divert 90 percent of flow to the FP&L reservoir via the Hoover Dike borrow canal; the excess water will be discharged into Lake Okeechobee through S-135.

(a) Proposed facilities

The existing borrow canal along the Hoover Dike is large enough to deliver 750 cfs flow from Taylor Creek/Nubbin Slough. However, a small gravity structure of 3-66" by 200 feet CMP culvert is required at S-191 to allow releases of water into the Hoover Dike borrow canal. The FP&L connection is the same as the one mentioned previously.

(b) Capital costs

Land cost	$ 24,200
3-66" 220' CMP culvert	177,000
1-750 cfs pumping station	3,000,000
Excavation	127,440
FP&L connection	1,810,000
TOTAL	$5,138,640

(3) Divert 90 percent of flow from Taylor Creek/Nubbin Slough to St. Lucie Canal via the Hoover Dike borrow canal by gravity.

(a) Proposed facilities

Three-66 inch by 200 feet long CMP culvert is required at S-191 to allow releases of water into the Hoover Dike borrow canal from Taylor Creek/Nubbin Slough. An additional spillway or culvert (3-66" 200 ft. long CMP culvert) will be required at the south end near S-308 for discharging water into the St. Lucie Canal.

(b) Capital costs

Land cost	$ 24,200
2-3 - 66" 200 ft. long CMP culvert	354,000
Excavation	127,440
TOTAL	$505,640

(4) Divert 90 percent of flow to the St. Lucie estuary via C-23 canal.

(a) Proposed facilities

The diversion of flow from Taylor Creek/Nubbin Slough can be achieved by routing the water through the Hoover Dike borrow canal via a small gravity flow structure (3-66" 200 feet CMP culvert). A channel connecting the borrow canal with the C-23 canal would be required with one 750 cfs pumping station to lift the water over the existing ridge. Improvement in the interconnection of C-23, C-24, and C-25 would be required.

(b) Capital costs

Land cost	$ 314,600
Channel excavation	2,655,000
Improvement to C-23, 24, 25	1,416,000
Culvert at S-191	177,000
Bridge at S.R. 714	159,300
Structure to C-23	194,700
One-750 cfs pumping station	3,000,000
	$7,916,600

(5) Divert 90 percent of flow to a reservoir prior to discharging into St. Lucie Estuary via C-23, C-24, C-25. This water would provide for irrigation for the areas served by C-23, C-24, and C-25 system. The routing result indicates a maximum stage of 37.2 ft. msl with an average stage at 32.3 ft. msl.

(a) Proposed facilities

The proposed reservoir will have the same facilities as proposed in storage option a.(1). The channel connection from C-59 to the 750 cfs pumping station and the reservoir to C-23 are required. In addition, improvement in the interconnection of C-23, C-24, and C-25 would also be required. A 750 cfs gravity gated spillway to discharge water into C-23 and one maintenance bridge west of the R/W of C-23 is required.

(b) Capital costs

Land cost and canal R/W	$36,002,700
Levee	11,365,000
Canal improvements (L-63S)	117,000
Structure to C-23	194,700
1-railroad bridge	590,000
1-highway bridge	240,000
Culverts at S-191	292,000
Improvement to C-23, 24, 25 connection	1,416,000

1-750 cfs pumping station	3,000,000
1-750 cfs gated spillway	1,200,000
1-80' maintenance bridge (one lane)	120,000
TOTAL	$54,537,500

d. On-site storage

There are approximately 82,257 acres of improved pasture in this basin to which this option would apply. The capital cost would be as follows:

Excavation and berming	$11.1 million
Cover crop	1.0 million
Underdrain system, outlet controls, fencing, etc.	1.1 million
TOTAL	$13.2 million

e. Conventional and R/O treatment

Evaluation of flow records indicates a 100 MGD plant would be necessary. From earlier calculations, then, an R/O plant would cost $127.4 million, whereas a conventional phosphorous treatment plant would cost $106 million.

2. Everglades Agricultural Area (S-2 and S-3)

a. Regional storage options

The management objective in the EAA is slightly different from the other major tributaries around Lake Okeechobee. In addition to eliminating or substantially reducing the nutrient load entering Lake Okeechobee, a subsidiary objective is to store as much of the water so removed from the lake in an alternative storage area(s), in or near the EAA for recycling into the agricultural area for irrigation purposes and/or discharging to the WCAs to meet other water supply demands; and water level management in such storage areas to be compatible insofar as possible with wildlife and other environmental considerations. For this reason primarily, the S-2 and S-3 basins were combined for analysis purposes. Therefore, the design of storage facilities in the EAA is slightly different from the rest of the tributary areas. A previous report on the Holeyland favored a 12 to 15 feet msl water level management schedule for the Holeyland reservoir, and a 1.5 foot water depth in the Rotenberger reservoir. This same schedule (0 to 3 feet water depth) was then applied to the Brown's Farm area and the Duda Ranch in the Hillsboro Canal basin. The hydrologic routing method, which is based on the principal of mass balance, was applied in this study, i.e.,

$$I - O = \Delta S / \Delta t$$

where

I = inflow in AF

O = outflow in AF

ΔS = storage change in each time step, AF

Δt = time step (1 month)

Inflow includes rainfall and runoff; outflow includes ET loss and seepage. ET loss was based on 80 percent of pan evaporation data obtained from a nearby station; the seepage function was based on bore tests made previously in the Holeyland. The amount of flow to be diverted to the proposed reservoir was based on the daily discharge duration curve for each stream flow during the wet season in the major tributary. Then, this value was multiplied by 30 days to determine design capacity. The outflow from the reservoir is assumed to be the same as the inflow capacity.

As mentioned previously, the supplementary irrigation demand and a 12 to 15 ft. msl regulation schedule was set up for Holeyland, Brown's Farm, and Duda Ranch reservoirs, whereas a 1.5 foot water depth (maximum) was used for the Rotenberger reservoir routings. Total runoff generated within the Miami Canal, North New River Canal, and Hillsboro Canal drainage areas was computed as the sum of daily outflows generated within the area. This was accomplished by adding the positive daily differences between inflows and outflows. In the Miami Canal basin this is equivalent to the total S-8 discharge minus the total discharge at the S-3-HGS 3 complex. In the North New River basin, it is the total discharge at S-7 and S-150 minus the discharge at the North New River Canal station below HGS 4. In the Hillsboro Canal basin, it is S-6 discharge minus S-2 discharge at Hillsboro Canal. The sign convention used on all discharge stations was that flow southward away from Lake Okeechobee be considered positive. Thus, when runoff was pumped into Lake Okeechobee from S-3 or S-2, the sign of this discharge was negative. Similarly, when discharges were made southward from S-6, S-7, or S-8, the discharge from these stations would be positive. If runoff was occurring at the same time on each end of the canal, subtracting a negative number from a positive number resulted in a combined positive number larger than the absolute value of either station and equal to the total runoff generated between these stations. The summations of the negative values of these differences were considered as irrigation demands.

The runoff values for the North New River canal basin are not exactly true representations of runoff because of the unique interconnection between this basin and the Hillsboro canal basin. This same interconnection will also affect the irrigation demand for the North New River basin. No attempt was made at the present to correct this estimate.

In all routings, the routed stages are allowed to recede to ground elevation and the moisture in the ground is allowed to recede to -0.50 to -1.0 ft. msl below ground elevation for ET and seepage losses. The stage in the reservoir is allowed to exceed its regulation schedule due to heavy rainfall in some wet months. Figure 4 shows the locations of the proposed storage areas.

(1) Hillsboro Canal Basin

The proposed reservoirs for this basin are located on state-owned lands, Duda Ranch, and Brown's Farm. As mentioned previously, the water management in the reservoir ranges between 0 ft. to 3 ft. of water depth with considerations of recycling water to meet demands. A routing based on 18 years of available record was performed with the assumptions of retaining 90 percent, 55 percent, and 50 percent of daily flow. The maximum water depths in the reservoir for 90 percent, 55 percent, 50 percent retention are 3.70, 3.70, and 3.70 feet, respectively; and the average water depths are 1.90, 1.90, and 1.80 feet, respectively. As far as the capital cost is concerned, the 50 percent daily flow retention is chosen because the storage of greater flows does not increase the detention value of the runoff to be treated (most would have to be released to Water Conservation Area 2A). These proposed reservoirs will provide about 62.4 percent of supplementary irrigation demand of the area. The amount of average annual flow from the basin that would be pumped into Water Conservation Area 2A is estimated about 76.8 percent. Thus, about 23.2 percent of the basin runoff is either provided by the reservoirs to meet local irrigation demands or lost to seepage and ET. Therefore, there would be a reduction of about 23.2 percent of the average annual flow available from this basin for storage in Water Conservation Area 2A.

(a) Proposed facilities

The storage areas are 5,760 acres (Duda Ranch) and 4,600 acres (Brown's Farm). Required levee heights are 7 feet above existing ground, with a 15 foot crown width and 1V on 3H side slope. "Coring" for the levees by removal of muck under the middle 15 feet of levee base is required for seepage reduction. The total length of required levee construction for the Duda Ranch is 14 miles and 8.6 miles for Brown's Farm. The system requires an intake canal and 150 cfs pumping station to lift water from the Hillsboro Canal to the reservoir, and a discharge canal with a 150 cfs, 84" CMP gated culvert structure for releasing water back into the Hillsboro Canal. The total length of connecting canal is 5.0 miles. In order to provide for increased conveyance in the Hillsboro Canal, excavation is required in the channel beginning about two miles west of Six-Mile Bend and ending six miles east of that point. This will reduce the chances for runoff generated in the area north of Six-Mile Bend to be backpumped into Lake Okeechobee in the future and increase the capacity of channel conveyance for the S-6 pumping station.

(b) Capital costs

Canal R/W = 60 x 1400	$ 84,000
Hillsboro Canal improvement	2,157,000
Demucking for core = $236,000 + $414,000	650,000
Rockfill placed = $1,110,000 + $1,998,000	3,108,000
Levee	3,898,000
2-150 cfs pumping station = 236,000 x 2	472,000
2-84" CMP gated culvert	280,000
TOTAL	$10,649,000

(2) Miami Canal and North New River Canal Basins

The routing study for the Holeyland and Rotenberger tract reservoirs was based on two different approaches. This study is an extension of the original study presented in an earlier District report.[1] The daily routing approach used in that report was for a period of record from January 1962 through December 1973. This evaluation extended the record from January 1974 through December 1979 based on a monthly time step. The proposed reservoir on the Holeyland tract under a 12 to 15 foot regulation schedule will meet about 60 percent of the irrigation demands from the recycling of water for the period January 1962 through December 1973 and about 63.6 percent of irrigation demands can be met for the period January 1974 through December 1979. In other words, there is no significant difference in the results based on a daily or monthly time step as used in this study. The average amount of runoff to the Water Conservation Areas from the North New River Canal is about 67.4 percent based on the routing results for 1974-79. That means there is a reduction of approximately 32.6 percent of runoff that can be discharged into the WCAs under this storage option. The maximum stage in the Holeyland reservoir is about 15.4 ft. msl, and 15.0 ft. msl for the Rotenberger tract reservoir.

(a) Holeyland reservoir

The perimeter levees will be required only on the north, east, and south sides; the existing levee of the Miami Canal on the west side being adequate in grade and cross-section for the considered regulation schedules. The south

[1]"Report on Investigation of Backpumping Reversal and Alternative Water Retention Sites, Miami Canal and North New River Canal Basins, Everglades Agricultural Area," prepared by C&SFFCD; December 1975.

perimeter levee is to be located north of the existing FP&L transmission line, at a distance approximately 450 feet north of the L-5 interior levee, which also serves as the access road to both S-8 and the transmission line towers. The required levee has a 10 foot crown width with side slopes of 1V on 2H and a top elevation of 19.0 ft. msl. "Coring" of the levee by removal of muck under the middle 10 feet of the levee base would be required. The total length of levee construction is 20.5 miles. The system requires two pumping stations of 550 cfs each and an intake channel from the North New River Canal to the proposed reservoir. The intake channel will be leveed on both sides and will be tied into the North New River Canal levee on the east and to the detention area levees on the west. Design grade for the intake canal levee will be at 17.5 ft. msl. Embankment material for the levee construction will be taken from adjacent continuous borrow canals. On the north and east sides the borrow canals will serve as seepage collectors. At the northeast corner of the retention area gated 42" culverts connecting the north and east borrow canals with the pumping station intake channel will be provided. The south perimeter levee borrow canal will be placed on the retention area side. No additional outlet capacity southward to Water Conservation Area No. 3A would be required since the existing outlets would be adequate. These consist of a four barrel 72" culvert installation 0.6 miles east of S-8 and a six barrel 72" culvert installation 3.5 miles east of S-8. The flashboard risers on all culverts would be replaced by gates.

Capital costs

2-42" culverts in seepage ditch	$ 14,700
Gating existing L-5 culverts	220,500
1-84" culvert in L-5 borrow canal	37,000
Gapping L-5 levee and tie-back	29,400
Intake canal levee	142,000
Bridge at U.S. Highway 27	220,500
2-72" culverts at each pumping station	265,000
2-550 cfs pumping stations	4,600,000
2-perimeter levees	5,172,000
2-intake canals	1,764,000
Land cost & canal R/W	890,900
TOTAL	$13,355,400

(b) Rotenberger tract reservoir

The levee design criteria are the same as for the Holeyland site except the requirement for "coring." There is no need for "coring" in this reservoir. Levees will be required on the north, west, and south perimeters. Total length of levee construction is 16.1 miles. The levee borrow canals on the north, west, and south sides will be placed on the outside and will act as seepage collectors. A ditch on the east side, inside the Miami Canal levee, will be required for distributing the water entering and leaving the reservoir. A 42" culvert with gate will be located in the eastern end of both the north and south levee to discharge seepage into the Miami Canal and maintain water levels as required. One 72" gated culvert will be placed through the existing Miami Canal west levee to discharge excess storage via the collector ditch. Two gated 72" culverts approximately six miles above S-8 will serve the same purpose. A 300 cfs pumping station located in the Miami Canal west levee will deliver water from the S-3 basin into the retention area. Two 72" culverts at this pumping station will act to discharge excess water via the collector ditch.

Capital costs

Land cost	$ 6,925,500
Levee and seepage ditch	1,420,000
3-culverts	1,176,000
1-300 cfs pumping station	1,300,000
Collector ditch	492,450
TOTAL	$11,313,950

(3) Combined storage on Holeyland and Duda tract

This option provides for storage on two areas rather than all four areas as described earlier. Flows in the Hillsboro Canal (S-2) basin would be stored on the Duda Tract. The Holeyland reservoir would store runoff generated in the S-3 basin and the North New River portion of the S-2 basin. Capital costs for the Holeyland reservoir would be the same as described in 2) a), above. Costs for this option are given below.

Duda Tract Reservoir

Hillsboro Canal improvement	$ 2,157,000
Canal R/W	31,500
"Coring" for levee	414,000

Rockfill placement	1,998,000
Levee	2,415,000
1-150 cfs pumping station	236,000
1-84" CMP gated culvert	140,000
SUB-TOTAL	$ 7,391,500
Holeyland reservoir	13,355,400
TOTAL	$20,746,900

(4) Combined storage on Holeyland for Miami, North New River, and Hillsboro Canal Basins

Instead of using four separate areas for storage of runoff as discussed earlier, this option utilizes only water storage on the Holeyland. The facilities would be the same as described in 2) a), above, except a divide structure would be required in the North New River Canal just south of its confluence with the Hillsboro Canal. This is the same concept as described in the District's report of December 1975, referenced earlier.

Capital costs

2-42" culverts in seepage ditch	$ 14,700
Gating existing L-5 culverts	220,500
1-84" culvert in L-5 borrow canal	37,500
Gapping L-5 and tie-back	29,400
Intake canal levee	142,000
Bridge at U.S. Highway 27	220,500
2-72" culverts at each pumping station	265,000
2-550 cfs pumping stations	4,600,000
2-perimeter levees	5,172,000
2-intake canals	1,764,000
Land cost & canal R/W	890,900
North New River Canal divide structure	1,123,000
TOTAL	$14,479,500

b. Diversion options

The most feasible diversion alternative in the EAA is the Interim Action Plan (IAP), which established a revised pumping schedule for the S-2 and S-3 basins to minimize backpumping to Lake Okeechobee. Experience with the IAP indicates that a 90 percent reduction in backpumping (diversion amount of 226,500 AF) through S-2 and S-3 can be accomplished on an average annual basis at no additional capital costs. Thus, for comparison with the other alternatives, the capital cost for implementing this alternative on a long-term basis was taken as zero.

c. On-site storage

Using the procedures described earlier, costs for this option were calculated to be as indicated below. Essentially, the cost of excavation and levee construction is the same as total cost.

Basin	Excavation and Levee Construction Cost, $ Million
S-2	$30.9
S-3	20.6
TOTAL	$51.5 Million

d. Conventional and R/O treatment plants

In terms of conventional treatment, two extended aeration/denitrification plants would be required, one at S-2 and one at S-3, as listed below.

Basin	Plant Size, MGD	Cost, $ Million
S-2	100	$ 96
S-3	50	52
	TOTAL	$148 Million

If R/O treatment plants were constructed, the breakdown would be as follows:

Basin	Plant Size, MGD	Cost, $ Million
S-2	100	$127.4
S-3	50	66.1
	TOTAL	$193.5 Million

3. Harney Pond Canal

a. Regional storage

The detention area is located in an area enclosed by levees L-60 and S.R. 78 which has an acreage of 9,883 acres. This area would be used to store runoff from the C-41 (S-71) basin.

(1) Divert 90 percent of daily flow into the proposed reservoir

The routing result based on 18 years of hydrologic data in the area indicates a maximum stage of 25.8 ft. msl with an average stage at 18.50 ft. msl. The required levee elevation is at 32 ft. msl, which is about 9 feet higher than the existing levee grade at L-60.

(a) Proposed facilities

A new levee located approximately 500 feet west of S.R. 78 is required with 20 feet crown width at 32 ft. msl elevation. The side slope for the levee is 1V on 3H. "Coring" of the levee will be required under the middle 20 feet of the levee base. Total length of this new levee is about 7.5 miles. One 960 cfs pumping station upstream of S-71 is needed to lift water from C-41 into the storage area, and a 960 cfs gated spillway structure is required about 500 feet upstream of the junction between S.R. 78 and C-41 to release water back into Lake Okeechobee.

(b) Capital cost

Land cost	$ 8,894,700
Levee	7,447,000
One 960 cfs pumping station	3,600,000
One 960 cfs gated spillway	1,000,000
TOTAL	$20,941,700

(2) Divert 50 percent of daily flow into the proposed reservoirs

The routing result indicates that a maximum stage of 22.4 ft. msl can be reached with an average stage of 18.1 ft. msl. The maximum stage is only 2.7 ft. less than the reservoir for retaining 90 percent daily flow and only 0.2 ft. less than average stage. Therefore, the levee criterion is the same as the one for 90 percent flow storage.

(a) Proposed facilities

The system requires a smaller pump (60 cfs capacity) and one 84" CMP gated culvert for discharging water back into Lake Okeechobee.

(b) Capital cost

Land cost	$ 8,894,700
Levee	7,400,000
One 60 cfs pumping station	95,000
One 84" gated CMP culvert	120,000
TOTAL	$16,509,700

b. On-site storage

The land use inventory indicates a total of 56,871 acres of improved pasture in the S-71 basin. On-site storage for this amount of acreage has the following cost breakdown.

Excavation and berming	$7.6 million
Cover crop	0.7 million
Underdrains, outlets, fencing, etc.	0.8 million
TOTAL	$9.1 million

c. Treatment by R/O

Analysis of flow records indicates a 100 MGD treatment plant would be required. An R/O plant of this size has a capital cost of $127.4 million.

4. Fisheating Creek Basin

a. Regional storage

(1) To store 90 percent of daily flow in the reservoir, the routing result indicates a maximum stage of 27.2 ft. msl can be reached with an average stage of 20.4 ft. msl. The storage area is 16,600 acres, plus the area below the 30.0 ft. msl which would require a flowage easement.

(a) Proposed facilities

Levee crown elevation would be 32.0 ft. msl, with a 20 feet top width and 1V on 3H side slope. The system requires a dam 8,500 feet long, 20 feet top width, and 1V on 6H and 1V on 4H side slope, and a gated spillway structure capable of discharging 12,000 cfs.

(b) Capital cost

Land cost	$23,520,000
Levee and dam	8,000,000

Gated spillway structure	4,000,000
TOTAL	$35,520,000

(2) To store 50 percent of daily flow in the reservoir, the routing result indicates a maximum stage of 23.3 ft. msl can be reached. The average stage is about 18.8 ft. msl.

(a) Proposed facilities

Same as 90 percent flow detention.

(b) Capital cost

Land cost @ 26 ft. msl	$14,800,000
Levee & dam	8,000,000
Gated spillway structure	4,000,000
TOTAL	$26,800,000

b. Diversion option

Diversion of 90 percent flow (about 1,100 cfs) can be accomplished via a diversion canal between Fisheating Creek at Palmdale and C-43 along the west side of the SCL RR.

(1) Proposed facilities

The diversion canal requires a cross-section of 25 feet bottom width, 1V on 2H side slope, 10 feet water depth. Total length of canal is 53,000 feet. The system requires two drop-type spillways at 1,100 cfs each. Four additional two-lane highway bridges with 100, 90, 85, and 75 ft. spans are required.

(2) Capital costs

Canal R/W	$ 315,000
Excavation	3,770,000
4 bridges	1,050,000
Two spillways	2,200,000
TOTAL	$7,335,000

c. On-site storage

From the land use data, there are approximately 80,280 acres of improved pasture which would require on-site storage systems. The cost breakdown for these systems is given below.

Excavation and berming	$10.8 million
Cover crop	1.0 million
Underdrains, outlets, fencing, etc.	1.1 million
TOTAL	$12.9 million

d. R/O treatment

Examination of flow records indicates a 100 MGD R/O plant would be necessary at a cost of $127.4 million.

5. Everglades Agricultural Area (S-4 Basin)

a. Diversion options

(1) Divert 90 percent of daily flow away from S-4 basin through S-235 to C-43.

(a) Proposed facilities

The existing LD-1 and LD-3 borrow canals need to be enlarged to deliver 800 cfs of discharge. The S-235 structure would need to be modified to an 800 cfs gated spillway structure.

(b) Capital cost

Canal excavation	$ 500,000
1-800 cfs gated spillway structure	900,000
TOTAL	$1,400,000

(2) Divert 90 percent of daily flow away from S-4 basin to Water Conservation Area 3A via a connection to L-1, L-2, and L-3 system. This system will require some enlargement of an existing canal.

(a) Proposed facilities

Enlarging the existing canal with unknown x-section and an 800 cfs pumping station to lift water from the S-4 basin into the L-1 canal would be required.

(b) Capital cost

Canal excavation	$ 700,000
1-800 cfs pumping station	3,000,000
TOTAL	$3,700,000

b. On-site storage

Using earlier described procedures, costs for this option were calculated to be $9.4 million. Basically, the cost of excavation and levee construction is the same as total cost.

c. Conventional and R/O treatment

Flow records indicate a 35 MGD plant would be necessary to treat the majority of the average annual flow in this basin. A 35 MGD extended aeration/denitrification plant would cost $38.0 million, whereas a 35 MGD R/O plant would cost $47.3 million.

6. Kissimmee River (C-38)

There are several options currently being considered by the U.S. Army Corps of Engineers for the Kissimmee River through their re-study of that basin. Since this effort is still underway, it was deemed inappropriate to perform a complete analysis of Kissimmee River alternatives. However, for comparative purposes, the cost of implementing on-site detention throughout the C-38 basin (south of S.R. #60) was determined. That cost breakdown is provided below. Approximately 192,800 acres of improved pasture would be involved.

Excavation and berming	$25.9 million
Cover crop	2.4 million
Underdrains, outlets, fencing, etc.	2.6 million
TOTAL	$30.9 million

C. Evaluation of Combined Alternatives

1. Impacts on Lake Okeechobee Water Budget

The amounts of inflow reduction to Lake Okeechobee due to temporary detention are functions of detention time and water depth, other climatical factors such as temperature, rainfall, wind, etc. A 0.8 coefficient was applied to pan evaporation data at HGS 6 for this analysis.

The assumption of ET coefficient is important in the hydrologic routing process, but the coefficient of 0.8 is a very fair value to be used in this area. John C. Stephens (1959) concluded that a 0.78 of pan data value for Florida watersheds was reasonable. A value of 0.70 of Class A pan data has been recommended for lake ET, and a value of 0.865 is used for Lake Okeechobee by the Corps of Engineers. For the purposes of this analysis, the value of 0.8 was, therefore, considered reasonable.

The following inflow reductions to Lake Okeechobee under various storage options were based on a coefficient of 0.8 of pan data.

Regional Storage Options

Basin	Storage Option	Average Annual Reduction - %	Period of Record, Years
Taylor Creek/	90% flow	0.5	7
Nubbin Slough	50% flow	0.5	7
C-41 basin	90% flow	1.7	17
	50% flow	1.4	17
Fisheating Creek	90% flow	3.0	17
	50% flow	1.9	17

Sub-regional Storage Options

Basin	Storage Option	Average Annual Reduction - %	Period of Record, Years
Taylor Creek	90% flow	0.13	17
	50% flow	0.13	17
Nubbin Slough	90% flow	0.64	7
	50% flow	0.67	7

Diversion Options

All the diversion options considered would divert about 90 percent of the daily flow from Taylor Creek/Nubbin Slough, Fisheating Creek, S-2 basin, S-3 basin, and S-4 basins. Therefore, the reduction of inflow to Lake Okeechobee would be on the order of 90 percent reduction from these tributaries. Thus, the impact to the lake's water budget would be significant.

On-site Storage

Daily routings based on six years of record were performed for each major tributary. The percent runoff reduction due to on-site detention of the first inch runoff were estimated. The results are listed in Table 14 . The variation of runoff reduction is also a function of other parameters such as ET, storm intensity, temperature, etc. The reduction would probably be more for dry years and less for wet years.

2. Ranking of Alternatives

As indicated earlier under "Goals and Guidelines," cost-effectiveness was used as the major criterion for ranking the various alternatives for each priority watershed. To calculate cost-effectiveness, the procedures described under "Methods of Analysis" were used to estimate total phosphorous and total nitrogen load reductions for each alternative in each priority watershed. Then, capital costs for each alternative (as presented earlier) were divided by the total P and

TABLE 14

AVERAGE ANNUAL RUNOFF REDUCTION

AFTER IMPLEMENTATION OF ON-SITE STORAGE

Basin	Runoff Reduction, AF/yr
Taylor Creek/Nubbin Slough (S-191)	18,000
EAA (S-2 and S-3)	25,500
Harney Pond Canal (S-71)	15,000
Fisheating Creek	20,900
EAA (S-4)	5,000
Kissimmee River (C-38)	67,800

total N load reductions, resulting in the cost to remove a unit amount of total P or total N (cost-effectiveness). The alternatives in each priority watershed were then ranked according to cost-effectiveness in reducing total P loads to the lake, except in the EAA (S-2, S-3, and S-4 basins) where cost-effectiveness in reducing total N was used in the rankings. Tables 15 through 19 present the results of the cost-effectiveness analysis, along with an estimate of the average annual inflow reduction of water to the lake for each alternative.

D. Conclusions

1. Preferred Alternatives

In order to develop a final ranking of preferred alternatives for implementation, an evaluation matrix approach was used. Factors used in that evaluation were derived from the study guidelines as outlined on page 4. These factors included capital cost, cost-effectiveness, total nutrient load reduction, removal of water to tide, and net loss of water from Lake Okeechobee. A weighted scale and point assignment was developed for each of these factors, which is provided in Tables 20-25. Each alternative listed in Tables 15-19 was then assigned a certain number of points on this basis. The results of the point assignments are presented in Table 26, Evaluation Matrix. The alternative with the lowest total points becomes the preferred alternative in that watershed. Final rankings of the alternatives, based on this broader evaluation, are presented in Tables 27-31. Table 32 gives the preferred alternative in each watershed and a summary of pertinent data for those options.

Essentially, the proposed alternative north of the lake involves on-site management of runoff utilizing BMPs in order to achieve the desired load reductions for individual land uses. This approach was selected because:

a. It was the least cost alternative which also met all of the study guidelines.

b. Available data demonstrates that this option has an excellent potential for achieving high nutrient removal efficiencies.

c. BMPs can be combined with current drainage practices with minimal impact on overall farming operations.

d. An institutional framework capable of implementing this alternative already exists.

In the EAA (S-2 and S-3), regional storage and water recycling using the Holeyland is the proposed alternative.

There are several reasons for proposing the implementation of this option, as follows:

a. Regional storage of runoff in the Holeyland provides for an additional water storage area for meeting a portion of the water supply demands on Lake Okeechobee and WCA #3.

TABLE 15

COST-EFFECTIVENESS ANALYSIS

(Before Screening)

Watershed: Taylor Creek/Nubbin Slough (S-191)

Desired Load Reductions: 168 Tons Total P, 302 Tons Total N

Rank	Alternative	Capital Cost, Million Dollars	Total P Load Reduction, Tons	Total N Load Reduction, Tons	Cost-effectiveness, Dollars/Pound		Inflow Reduction, AF
					Total P	Total N	
1	Divert 90% of average annual flow to St. Lucie Canal via Hoover Dike borrow canal, by gravity	0.5	169.8	430.1	1.47	0.58	138,200
2	Divert 90% of average annual flow to FPL reservoir and St. Lucie Canal via L-63S, L-64, and L-65	7.5	169.8	430.1	22.08	8.72	138,200
3	Divert 90% of average annual flow to St. Lucie County, connect to C-23	7.9	169.8	430.1	23.26	9.18	138,200
4	Divert 90% of average annual flow to FPL reservoir and return excess to Lake Okeechobee via S-135 (via Hoover Dike borrow canal); 50,000 AF annually to FPL reservoir	5.1	61.5-99.7	155.5-252.2	25.58-41.46	10.11-16.40	50,000
5	On-site detention of runoff	13.2	167.4	318.7	39.43	20.71	18,000
6	Divert 90% of average annual flow to St. Lucie County, with intermediate storage in an above ground reservoir	54.5	169.8	430.1	160.48	63.36	138,200

TABLE 15 (CONTINUED)

COST-EFFECTIVENESS ANALYSIS

(Before Screening)

Watershed: Taylor Creek/Nubbin Slough (S-191), continued

Rank	Alternative	Capital Cost, Million Dollars	Total P Load Reduction, Tons	Total N Load Reduction, Tons	Cost-effectiveness, Dollar/Pound		Inflow Reduction, AF
					Total P	Total N	
7	Regional storage, 90% of average annual flow	52.7	50.9-75.5	129.0-191.2	349.0.-517.68	137.81-204.26	$<$ 1,000
8	Reverse osmosis treatment plant at S-191 (100 MGD plant)	127.4	152.9	387.1	416.61	164.56	34,500
9	Conventional phosphorous treatment plant	106.0	125.5	167.2	422.31	316.99	$<$ 1,000
10	Regional storage, 50% of average annual flow	40.3	28.3-47.2	71.7-119.5	426.91-712.01	168.62-281.03	$<$ 1,000
11	Subregional storage (2 reservoirs), 90% of average annual flow	75.2	50.9-75.5	129.0-191.2	498.01-738.70	196.65-291.47	$<$ 1,000
12	Subregional storage (2 reservoirs), 50% of average annual flow	71.6	28.3-47.2	71.7-119.5	758.47-1265.02	299.58-499.30	$<$ 1,000

TABLE 16

COST-EFFECTIVENESS ANALYSIS

(Before Screening)

Watershed: Everglades Agricultural Area (S-2 and S-3)

Desired Load Reductions: 13 Tons Total P, 1670 Tons Total N

Rank	Alternative	Capital Cost, Million Dollars	Total P Load Reduction, Tons	Total N Load Reduction, Tons	Cost-effectiveness, Dollars/Pound		Inflow Reduction, AF
					Total P	Total N	
1	Interim Action Plan (divert 90% of average annual flow)	No additional cost	38.2	1724.6	0.0	0.0	226,500
2	Regional storage, 90% of average annual flow on Holeyland tract	14.5	38.2	1724.6	189.79	4.20	226,500 (Note that irrigation demands on lake would be reduced by about 60%, however.)
3	Regional storage, 90% of average annual flow on Holeyland and Trustees Tract (0'-4' regulation schedule)	20.0	38.2	1724.6	261.78	5.8	226,500 (Note that irrigation demands on lake would be reduced by about 60%, however).
4	Subregional storage, 90% of average annual flow (Rotenberger Tract, Holeyland, Trustees Tract, Brown's Farm)	34.6	38.2	1724.6	452.88	10.03	226,500 (Note that irrigation demands on lake would be reduced by about 60%, however.)
5	On-site storage, first 1.0 inch of runoff	51.5	12.8-21.4	482.0-803.4	1203.27-2011.72	32.05-53.42	25,500
6	Conventional treatment plants, extended aeration -- denitrification (100 MGD at S-2, 50 MGD at S-3)	148.0	13.5	1073.1-1379.6	5481.48	53.64-68.96	< 1,000

TABLE 16 (CONTINUED)

COST-EFFECTIVENESS ANALYSIS

(Before Screening)

Watershed: Everglades Agricultural Area (S-2 and S-3)

Rank	Alternative	Capital Cost, Million Dollars	Total P Load Reduction, Tons	Total N Load Reduction, Tons	Cost-effectiveness, Dollars/Pound		Inflow Reduction, AF
					Total P	Total N	
7	Reverse osmosis treatment plants (100 MGD at S-2, 50 MGD at S-3)	193.5	30.5	1379.6	3172.13	70.13	50,300

TABLE 17

COST-EFFECTIVENESS ANALYSIS

(Before Screening)

Watershed: Harney Pond Canal (S-71)

Desired Reductions: 28 Tons Total P, 158 Tons Total N

Rank	Alternative	Capital Cost, Million Dollars	Total P Load Reduction, Tons	Total N Load Reduction, Tons	Cost-effectiveness, Dollars/Pound		Inflow Reduction, AF
					Total P	Total N	
1	On-site detention of runoff	9.1	38.0	225.4	119.74	20.19	15,000
2	Regional storage, 90% of average annual flow	20.9	16.2-27.0	140.8-234.7	387.04-645.06	44.52-74.22	2,900
3	Regional storage, 50% of average annual flow	16.5	9.0-15.0	78.2-130.5	550.00-916.67	63.22-105.50	2,400
4	Reverse osmosis treatment plant (100 MGD)	127.4	38.1	261.6	1671.92	243.50	38,200

TABLE 18

COST-EFFECTIVENESS ANALYSIS

(Before Screening)

Watershed: Fisheating Creek

Desired Load Reductions: 14 Tons Total P, 141 Tons Total N

Rank	Alternative	Capital Cost, Million Dollars	Total P Load Reduction, Tons	Total N Load Reduction, Tons	Cost-effectiveness, Dollars/Pound		Inflow Reduction, AF
					Total P	Total N	
1	Divert 90% of average annual flow to C-43 (along west side of SCL railroad)	7.3	58.5	516.1	62.39	7.07	183,100
2	On-site detention of runoff	12.9	48.2	298.3	133.82	21.62	20,900
3	Regional storage, 90% of average annual flow	35.5	17.6-29.3	154.9-258.1	605.80-1008.52	68.77-114.59	6,100
4	Regional storage, 50% of average annual flow	26.8	9.8-16.3	86.1-143.3	822.09-1367.35	93.51-115.63	3,900
5	Reverse osmosis treatment plant (100 MGD)	127.4	52.7	464.5	1208.73	137.14	45,800

TABLE 19

COST-EFFECTIVENESS ANALYSIS

(Before Screening)

Watershed: Everglades Agricultural Area (S-4)

Desired Load Reductions: 8 Tons Total P, 80 Tons Total N

Rank	Alternative	Capital Cost, Million Dollars	Total P Load Reduction, Tons	Total N Load Reduction, Tons	Cost-effectiveness, Dollars/Pound		Inflow Reduction, AF
					Total P	Total N	
1	Divert 90% of average annual flow to C-43 via S-235	1.4	13.4	127.4	52.24	5.50	31,400
2	Divert 90% of average annual flow to WCA #3A via L-1, L-2, and L-3	3.7	13.4	127.4	138.06	14.52	31,400
3	On-site storage, first 1.0 inch of runoff	9.4	4.6-7.7	44.8-74.6	610.39-1021.74	63.0-104.91	5,000
4	On-site storage, first 0.5 inch of runoff	5.5	3.3	31.9	833.33	86.21	8,200
5	Reverse osmosis treatment plant (35 MGD)	47.3	12.0	114.6	1971.00	206.37	7,900
6	Conventional treatment plant, extended aeration-denitrification (35 MGD)	38.0	5.4	79.3-102.0	3518.52	186.28-239.60	<1,000

TABLE 20

CAPITAL COST SCALE

Point Assignment	Range, $ Million
0	0
1	0 - 5.0
2	5.1 - 6.0
3	6.1 - 7.0
4	7.1 - 8.0
5	8.1 - 9.0
6	9.1 - 10.0
7	10.1 - 12.5
8	12.6 - 15.0
9	15.1 - 20.0
10	20.1 - 30.0
15	30.1 - 40.0
25	40.1 - 50.0
50	>50.0

TABLE 21

COST-EFFECTIVENESS SCALE, TOTAL P

Point Assignment	Range, Dollars/Pound
0	0
1	0 - 25.00
2	25.01 - 50.00
3	50.01 - 75.00
4	75.01 - 100.00
5	100.01 - 125.00
6	125.01 - 150.00
7	150.01 - 175.00
8	175.01 - 200.00
9	200.01 - 225.00
10	225.01 - 250.00
15	250.01 - 300.00
25	300.01 - 400.00
50	> 400.00

TABLE 22

COST-EFFECTIVENESS SCALE, TOTAL N

Point Assignment	Range, Dollars/Pound
0	0
1	0 - 5.00
2	5.01 - 10.00
3	10.01 - 15.00
4	15.01 - 20.00
5	20.01 - 25.00
6	25.01 - 30.00
7	30.01 - 35.00
8	35.01 - 40.00
9	40.01 - 45.00
10	45.01 - 50.00
15	50.01 - 60.00
25	60.01 - 80.00
50	>80.0

TABLE 23

NUTRIENT LOAD REDUCTION SCALE

(TOTAL P AND TOTAL N)

Point Assignment	Range, % of Desired Load Reduction
0	100%
1	95.0 - 99.9
2	90.0 - 94.9
3	85.0 - 89.9
4	80.0 - 84.9
5	75.0 - 79.9
6	70.0 - 74.9
7	65.0 - 69.9
8	60.0 - 64.9
9	55.0 - 59.9
10	50.0 - 54.9
15	40.0 - 49.9
25	25.0 - 39.9
50	< 25.0

TABLE 24

REMOVAL OF WATER TO TIDE SCALE

Point Assignment	Range, AF/yr
0	0
1	0 - 10,000
2	10,001 - 20,000
3	20,001 - 30,000
4	30,001 - 40,000
5	40,001 - 50,000
6	50,001 - 60,000
7	60,001 - 70,000
8	70,001 - 80,000
9	80,001 - 90,000
10	90,001 - 100,000
15	100,001 - 125,000
25	125,001 - 175,000
50	>175,000

TABLE 25

NET LOSS OF WATER FROM LAKE OKEECHOBEE SCALE

Point Assignment	Range, AF/yr	Range, % of Total Lake Inflow
0	0	0
1	0 - 17,800	0 - 0.5
2	17,801 - 35,600	0.51 - 1.0
3	35,601 - 53,400	1.01 - 1.5
4	53,401 - 71,200	1.51 - 2.0
5	71,201 - 89,000	2.01 - 2.5
6	89,001 - 106,800	2.51 - 3.0
7	106,801 - 124,600	3.01 - 3.5
8	124,601 - 142,400	3.51 - 4.0
9	142,401 - 160,200	4.01 - 4.5
10	160,201 - 178,000	4.51 - 5.0
15	178,001 - 213,600	5.01 - 6.0
25	213,601 - 267,000	6.01 - 7.5
50	> 267,000	> 7.5

TABLE 26

EVALUATION MATRIX

Alternative	Capital Cost	Cost-effectiveness Total P	Cost-effectiveness Total N	Nutrient Load Reduction Total P	Nutrient Load Reduction Total N	Removal of Water to Tide	Loss of Water from Lake Okeechobee	Total Points
Taylor Creek/Nubbin Slough 1	1	1	1	0	0	25	8	36
Taylor Creek/Nubbin Slough 2	4	1	2	0	0	25	8	40
Taylor Creek/Nubbin Slough 3	4	1	2	0	0	25	8	40
Taylor Creek/Nubbin Slough 4	2	2	3	10	7	5	3	32
Taylor Creek/Nubbin Slough 5	8	2	5	0	0	0	2	17
Taylor Creek/Nubbin Slough 6	50	7	25	0	0	25	8	115
Taylor Creek/Nubbin Slough 7	50	25	50	15	10	0	1	151
Taylor Creek/Nubbin Slough 8	50	50	50	2	0	0	2	154
Taylor Creek/Nubbin Slough 9	50	50	50	6	9	0	1	166
Taylor Creek/Nubbin Slough 10	25	50	50	25	25	0	1	176
Taylor Creek/Nubbin Slough 11	50	50	50	15	10	0	1	176
Taylor Creek/Nubbin Slough 12	50	50	50	25	25	0	1	201
Everglades Agricultural Area 1	0	0	0	0	0	0	25	25
Everglades Agricultural Area 2	8	8	1	0	0	0	6	23
Everglades Agricultural Area 3	9	15	2	0	0	0	6	32
Everglades Agricultural Area 4	15	50	3	0	0	0	6	74
Everglades Agricultural Area 5	50	50	10	0	15	0	2	127
Everglades Agricultural Area 6	50	50	15	0	6	0	1	122
Everglades Agricultural Area 7	50	50	25	0	4	0	3	132
Harney Pond Canal 1	6	5	5	0	0	0	1	17
Harney Pond Canal 2	10	50	15	5	1	0	1	82
Harney Pond Canal 3	9	50	25	15	7	0	1	107
Harney Pond Canal 4	50	50	50	0	0	0	3	153
Fisheating Creek 1	4	3	2	0	0	50	15	74
Fisheating Creek 2	8	6	5	0	0	0	2	21
Fisheating Creek 3	15	50	50	0	0	0	1	116
Fisheating Creek 4	10	50	50	4	4	0	1	119
Fisheating Creek 5	50	50	50	0	0	0	3	153

TABLE 26 (CONTINUED)

EVALUATION MATRIX

Alternative	Capital Cost	Cost-effectiveness Total P	Total N	Nutrient Load Reduction Total P	Total N	Removal of Water to Tide	Loss of Water from Lake Okeechobee	Total Points
S-4 Basin 1	1	3	2	0	0	4	2	12
S-4 Basin 2	1	6	3	0	0	0	2	12
S-4 Basin 3	6	50	25	5	5	0	1	92
S-4 Basin 4	2	50	50	15	25	0	1	143
S-4 Basin 5	25	50	50	0	0	0	1	126
S-4 Basin 6	15	50	50	7	0	0	1	123

TABLE 27

FINAL RANKING

WATERSHED: TAYLOR CREEK/NUBBIN SLOUGH (S-191)

Rank	Alternative	Total Points
1	On-site management	17
2	Divert 90% of average annual flow to FPL reservoir and return excess to Lake Okeechobee via S-135	32
3	Divert 90% of average annual flow to St. Lucie Canal via Hoover Dike borrow canal, by gravity	36
4	Divert 90% of average annual flow to FPL reservoir and St. Lucie Canal via L-63S, L-64 and L-65	40
4	Divert 90% of average annual flow to St. Lucie County, connect to C-23	40
5	Divert 90% of average annual flow to St. Lucie County, with intermediate storage in above ground reservoir	115
6	Regional storage, 90% of average annual flow	151
7	Reverse osmosis treatment plant at S-191	154
8	Conventional treatment plant at S-191	166
9	Regional storage, 50% of average annual flow	176
10	Subregional storage, 90% of average annual flow	176
11	Subregional storage, 50% of average annual flow	201

TABLE 28

FINAL RANKING

WATERSHED: EVERGLADES AGRICULTURAL AREA (S-2 AND S-3)

Rank	Alternative	Total Points
1	Regional storage on Holeyland Tract	23
2	Interim Action Plan	25
3	Regional storage on Holeyland Tract and Trustees Tract	32
4	Subregional storage (Rotenberger, Holeyland, Trustees Tract, and Brown's Farm)	74
5	Conventional treatment plants at S-2 and S-3	122
6	On-site storage	127
7	Reverse Osmosis treatment plants	132

TABLE 29

FINAL RANKING

WATERSHED: HARNEY POND CANAL (S-71)

Rank	Alternative	Total Points
1	On-site Management	17
2	Regional storage, 90% of average annual flow	82
3	Regional storage, 50% of average annual flow	107
4	Reverse osmosis treatment plant	153

TABLE 30

FINAL RANKING

WATERSHED: FISHEATING CREEK

Rank	Alternative	Total Points
1	On-site management	21
2	Divert 90% of average annual flow to C-43	74
3	Regional storage, 90% of average annual flow	116
4	Regional storage, 50% of average annual flow	119
5	Reverse osmosis treatment plant	153

TABLE 31

FINAL RANKING

WATERSHED: EVERGLADES AGRICULTURAL AREA (S-4)

Rank	Alternative	Total Points
1	Divert 90% of average annual flow to C-43 via S-235	12
1	Divert 90% of average annual flow to WCA #3A via L-1, L-2 and L-3	12
2	On-site management (first inch of runoff)	92
3	Conventional treatment plant	123
4	Reverse osmosis treatment plant	126
5	On-site management (first half-inch of runoff)	143

TABLE 32

Summary of Preferred Alternatives

Watershed	Alternative	Capital Cost, $ Million	Total P Reduction, Tons: After Controls	Total P Reduction, Tons: Required	Total N Reduction, Tons: After Controls	Total N Reduction, Tons: Required	Net Water Losses to Lake, AF
Taylor Creek/ Nubbin Slough (S-191)	On-site management	13.2	169.8	168	302.7	302	18,000
S-2 and S-3	Holeyland	14.5	38.2	17	1724.6	1670	90,600[1]
Harney Pond Canal (S-71)	On-site management	9.1	28.8	28	189.4	154	15,000
Fisheating Creek	On-site management	12.9	30.8	14	213.4	141	20,900
S-4	Diversion to C-43	1.4	13.4	8	127.4	80	31,400
C-38[2]	On-site management	30.9	40.7	33	493.2	354	67,800
TOTAL OVERALL DESIRED REDUCTIONS		82.0	321.7	268	3050.7	2705	243,700

[1]Note that irrigation demands on lake would be reduced by about 60 percent; hence, net loss would be about 90,600 AF instead of 226,500 AF.

[2]This is only one of many alternatives currently being considered by the U.S. A.C.E. in the re-study of the Kissimmee River and has not been selected as the least cost alternative. The figures are presented for comparative purposes only.

b. Regional storage and water recycling is the least cost alternative which also meets the guidelines established during the study.

c. Compared with the Interim Action Plan, there is less of a loss of water to Lake Okeechobee on an average annual basis (90,600 AF compared to 226,500 AF).

d. Regional storage has a greater probability of achieving nitrogen load reductions to Lake Okeechobee than on-site storage since runoff would be physically diverted away from the lake, whereas it would be treated to some degree and released back to the system through on-site storage.

e. Regional storage has the potential to provide more benefits to WCA #3 than the other options if excess water is available for discharge from the Holeyland. These potential benefits include:

   (1) A portion of the excess runoff generated in the S-7 and S-8 basins would be treated to some degree prior to being discharged to WCA #3.

   (2) Some degree of sheetflow over the north end of WCA #3 can be reestablished by discharging excess water from the Holeyland at several locations along the northern levee of WCA #3.

f. Considerable preliminary work has already been accomplished regarding the Holeyland storage concept through both the Special Project to Prevent the Eutrophication of Lake Okeechobee and current activities of the Army COE. Specifically, the Holeyland area is being examined as a possible additional water storage area in the COE's Water Supply Study for South Florida.

2. Deleted Alternatives

Based on the results of the evaluation (screening) matrix and the final rankings (Tables 27-31), alternatives other than the number I ranked alternative were deleted from further consideration.

IV. RECOMMENDATIONS

A. General Management Strategy

The implementation of management actions in the Lake Okeechobee region is a very ambitious endeavor; therefore, it is proposed that a phased approach over a number of years be used.

Phase I is composed of five major activities:

...Continuation of the Interim Action Plan (IAP) for five years.

...Initiation and construction of the Holeyland project in the EAA.

...Acceleration of implementation of BMP programs in the Taylor Creek/ Nubbin Slough basin.

...Implementation of an expanded regulatory program which includes water quality limitations for any new construction of drainage systems in all areas tributary to Lake Okeechobee.

...Continuation and completion of the Kissimmee River Survey Review.

The IAP reduced backpumping to Lake Okeechobee as a means of reducing nutrient loads. Until the Holeyland project is in place and operational, the IAP will be in effect. The initiation and construction of the Holeyland project is anticipated to take five years.

A program to support and augment the current BMP implementation efforts in the Taylor Creek/Nubbin Slough basin will be promoted by the District. A five-year implementation period has been allotted for the completion of this element of Phase I. Additionally, the completion of the Kissimmee Survey Review at an early date will be achieved by continued cooperation and coordination with the Corps of Engineers and other agencies involved in the Kissimmee River Restudy.

Throughout the District, this agency presently regulates existing and new agricultural and urban surface water management systems. It is proposed to broaden the regulatory activity to include water quality requirements for new agricultural construction in areas tributary to Lake Okeechobee. This approach will aid in preventing an increase in nutrient loadings to the lake from the surrounding areas. New construction would include modifications of existing systems due to more intensive land use or development of raw land, for agricultural and urban purposes. Finally, Phase I includes continuation of the District's existing water quality monitoring program for Lake Okeechobee and the basins tributary to it.

The conclusion of Phase I will mark a major milestone and a "fork in the road." At that time, progress toward implementation of management actions will be assessed to determine what steps will be necessary in Phase 2. Among the issues to be considered under Phase 2 are the following:

1. Should the District's current regulatory program be expanded to include water quality control requirements for existing drainage systems in order to achieve compliance with the load allocation?

2. How much further reduction in nutrient loading is necessary from the tributaries other than S-191, S-2, and S-3?

3. How effective have the management actions already taken been in improving water quality?

4. Are other water quality trends emerging?

In support of the general management strategy to reduce nutrient loads to Lake Okeechobee, a timetable was developed for implementation of actions.

Figure 5 simplifies the process developed and outlines a sequence of tasks which will take, in all, five years to accomplish. The graph is based on a ten-year time frame to indicate those programs which will continue beyond the proposed five-year implementation period.

B. Everglades Agricultural Area

1. Interim Action Plan

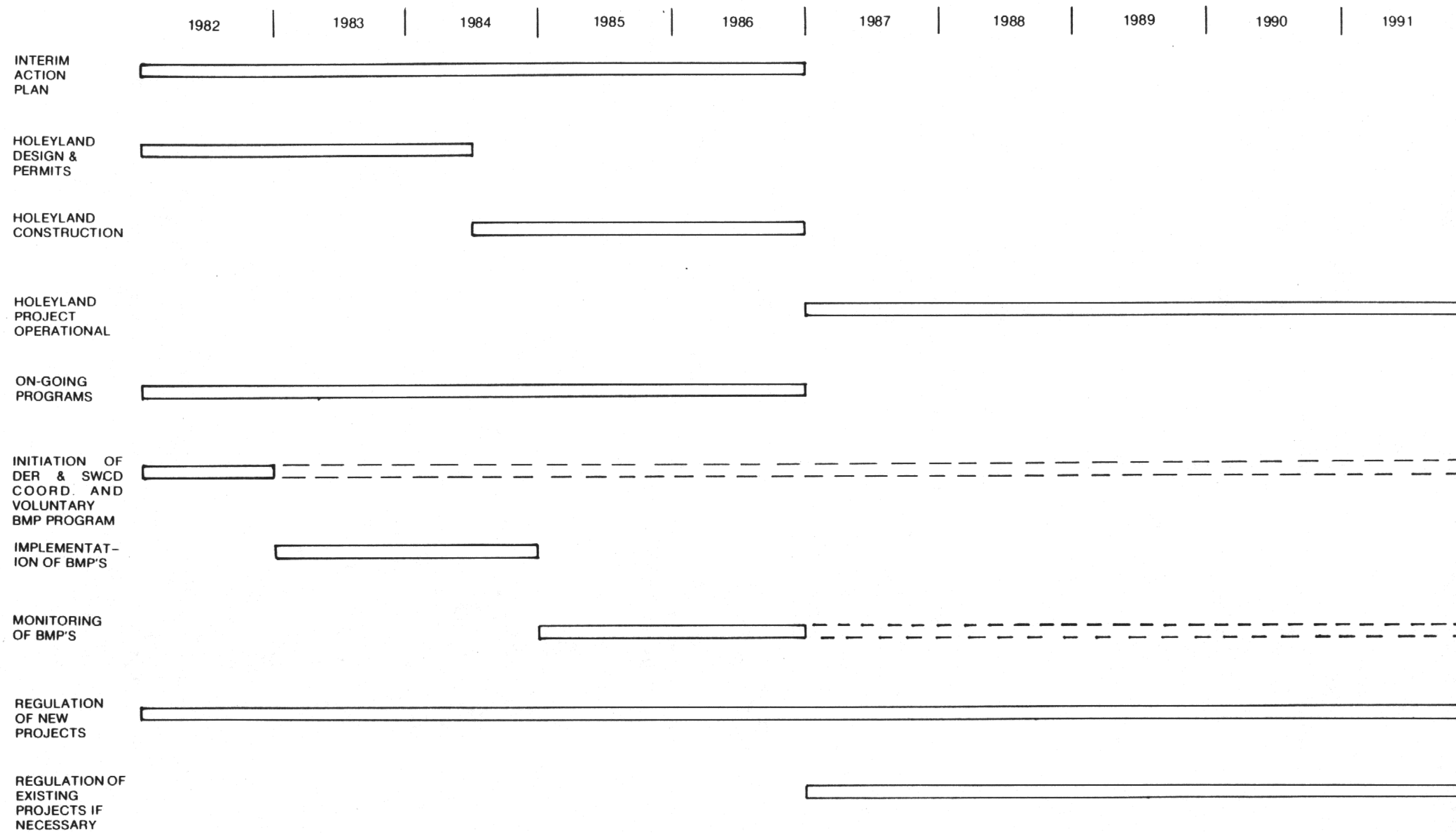
An Interim Action Plan (IAP) was devised for reducing nutrient loading to Lake Okeechobee during the term of the Temporary Operating Permit (T.O.P.). In order to reduce nutrient loading to the lake through S-2 and S-3, the Department of Field Services developed a modified pumping schedule for the Everglades Agricultural Area. This plan reduced the amount of water backpumped into the lake and directs it south to the Water Conservation Areas, thereby reducing the nutrient load to Lake Okeechobee.

It is proposed to continue the Interim Action Plan until such time as another means of reducing the nutrient load to the lake from the EAA is in place. However, the IAP must be modified to allow for backpumping into the lake during periods of water shortage such as have been experienced in 1981. In June 1981, the IAP was suspended at the request of the District and with the concurrence of the DER because of the drought being experienced within our District.

To prevent a further need to suspend the IAP during times of water shortage, the District staff revised it. Under the modified IAP, which was approved at the June 1982 Governing Board meeting, backpumping through S-2 and S-3 would be allowed until the nitrate-nitrogen concentrations reach 1.0 mg/l as N. At this point, backpumping would be terminated and primary flow redirected southward to the Water Conservation Areas (WCAs) through the southerly pump stations (S-6, S-7, and S-8). This strategy would remain in effect as long as the lake stage remains below the long-term historical average. Once the lake stage exceeds the historical average, then the original IAP becomes operational. Two exceptions to this are:

FIGURE 5

5 YEAR IMPLEMENTATION SCHEDULE



a. When the basin is being subjected to a potential flood due to excess runoff beyond the safe capacity of the southerly pump stations; and

b. When nitrate levels at S-6, S-7, and S-8 return to acceptable concentrations (i.e., less than 1.0 mg/l) and the lake stage is below the historical average.

As stated previously, the IAP, with this revision, will remain in effect until other measures to reduce nutrient loadings to the lake are operational.

2. Long-term Solution

In the S-2 and S-3 basins south of the lake, analysis of the technical alternatives has determined that a regional storage option is the most cost-effective method on a long-term basis of mitigating the water quality problems experienced by Lake Okeechobee. Additionally, this alternative meets the guidelines as set forth earlier in this report. The Holeyland is proposed as a water storage area as well as providing a water quality enhancement feature for the lake. The primary drawback to the Interim Action Plan is that the water is lost from storage in Lake Okeechobee.

This project is part of the Corps of Engineers (COE) Central and Southern Florida Water Supply Survey Review. The preliminary planning has been conducted and the resulting information can be used in the project design phase of the program. A combined General Design Memorandum and Detailed Design Memorandum must be developed by the COE, supported by the District and at the state level, and approved by Congress for funding to be approved for construction. This is merely an outline of a complex series of procedures that must be followed to accomplish construction of the Holeyland project; however, it is expected that this project will be operational at the end of five years.

C. <u>Taylor Creek/Nubbin Slough (S-191)</u>

Many programs are in existence which are providing financial support needed for the implementation of Best Management Practices (BMPs) as well as the data to analyze and evaluate the effectiveness of these practices in terms of reducing nutrient loads. Some of these programs are funded by the federal government through the local Agricultural Stabilization and Conservation Service (ASCS) offices, with Soil Conservation Service (SCS) providing technical support.

The Taylor Creek/Nubbin Slough area was funded through the Rural Clean Waters Program (RCWP) which is being administered through the local ASCS Okeechobee office. Only 33 watersheds in the nation were selected for funding through this program. Over one million dollars have been allocated by the federal government for the implementation and evaluation of BMPs in this watershed. The District has been involved with this program from its inception and has assumed a leadership role in concert with the ASCS and SCS. Recently initiated, the program has a life of approximately 10 years.

Other programs are in existence; for example, the Upland Retention/Detention Demonstration Project which was initiated by the Coordinating Council on the Restoration of the Kissimmee River and Taylor Creek/Nubbin Slough. It involves the installation of BMPs at five sites located throughout the Lower Kissimmee River Valley and Taylor Creek/Nubbin Slough. This program has been administered and implemented jointly by the Council and the District. Another existing and on-going program in this area is the Taylor Creek Headwaters Project, also initiated by the Coordinating Council and inherited by the District this past spring.

The District has been and is currently assuming a leadership role in all of the programs. The experience with the design and implementation of BMPs, the data collected before and after installation of the BMPs, and the communication between the District and the farmers in the area in invaluable opportunities to develop and implement a feasible plan to reduce nutrient loadings to Lake Okeechobee.

The analysis of the technical alternatives generally shows that in the basins north of Lake Okeechobee and tributary to it, on-site management (Best Management Practices) should be implemented to reduce nutrient loadings to the lake. These BMPs include fencing, shade structures, runoff detention, barnwash recycling, dairy barn lagoons, etc. (see Table 13).

To implement BMPs, an initial non-regulatory approach is recommended for Phase I of the implementation strategy.

Other state programs are emerging to provide coordinated technical and some financial assistance towards the implementation of BMPs. The Department of Environmental Regulation, in support of the Agricultural Nonpoint Source Element of the State Water Quality Management Plan, has developed a state strategy for the implementation of BMPs. This program proposes a "non-regulatory" or voluntary program administered statewide by the DER and implemented using the authority and resources of County Soil and Water Conservation Districts, in cooperation with the ASCS, SCS, and the Florida Department of Agriculture and Consumer Services. The Institute of Food and Agricultural Sciences is proposed as the agency to provide research assistance in evaluating the effectiveness of BMPs as to their impact on the quality of receiving waters and their impact on agricultural production. It is proposed that increased funding for cost sharing assistance be requested, particularly through the new activities of the Florida Department of Agriculture and Consumer Services.

This approach has several advantages:

1. No reorganization of existing agencies or creation of new ones is needed to go forward with implementation.

2. Coordination of work effort may result in a unified approach to assist the farmer, and the framework of this plan provides an opportunity for the agricultural community and the agencies involved to come to a concensus as to the effectiveness of BMPs in terms of reduction of nutrient loads and the impacts of BMPs on agricultural production.

3. By the coordination of funding opportunities, technical assistance and information as well as research resources, incentives can be offered to the farmer that are greater than if each agency operates separately. Also, government will take care of the coordination, not the farmer.

This first phase non-regulatory approach for existing operations is recommended because of the current uncertainty regarding the effectiveness of BMPs. Additionally, experience over time will allow the District to develop criteria which could be used effectively in a modified regulatory program, if such is deemed necessary for existing systems.

APPENDICES

LIST OF APPENDICES

APPENDIX I

LAND USE/LOADING ANALYSIS

1979 LAND USE/LAND COVER DATA

East Beach Drainage District Basin

SFWMD	DOT		ACREAGE	SUB-TOTAL	PERCENT
ACSC	216	SUGAR CANE	4312	4481	83.80
ACTC	214	TRUCK CROPS	169		
BP	742	EXTRACTIVE	6	6	.11
HO	520	OPEN FRESH WATER	3	3	.06
UCSS	141	SALES & SERVICES	77	857	16.03
UI	150	INDUSTRIAL	3		
UOPK	185	PARKS	1		
UORC	186	RECREATIONAL FACILITY	4		
UOUN	191	OPEN AND UNDEVELOPED	33		
URMF	134	MULTI-FAMILY	122		
URMH	122	MOBILE HOMES	15		
URSL	111	SINGLE FAMILY LOW DENSITY	229		
URSM	121	SINGLE FAMILY MEDIUM DENSITY	305		
USED	171	EDUCATIONAL FACILITY	38		
USMD	174	MEDICAL FACILITY	5		
USRL	172	RELIGIOUS	7		
UTSP	834	SEWERAGE TREATMENT FACILITY	18		
TOTAL AREA			5347		100.00

1979 LAND USE/LAND COVER DATA

715 Farm Drainage District Basin

SFWMD	DOT		ACREAGE	SUB-TOTAL	PERCENT
ACSC	216	SUGAR CANE	2924	2924	88.63
BL	744	LEVEES	97	97	2.94
UOPK	185	PARKS	15		
URSL	111	SINGLE FAMILY LOW DENSITY	24	278	8.43
UTAP	811	AIRPORTS	239		
TOTAL AREA			3299		100.00

1979 LAND USE/LAND COVER DATA

East Shore Drainage District Basin

SFWMD	DOT		ACREAGE	PERCENT
ACSC	216	SUGAR CANE	8457	100
TOTAL AREA			8457	100

1979 LAND USE/LAND COVER DATA

South Shore Drainage District Basin

SFWMD	DOT		ACREAGE	SUB-TOTAL	PERCENT
ACSC	216	SUGAR CANE	2522	2522	85.69
BL	744	LEVEES	44	44	1.50
UCSS	141	SALES & SERVICES	9		
UOUN	191	OPEN AND UNDEVELOPED	14		
URMF	134	MULTI-FAMILY	30	377	12.81
URMH	122	MOBILE HOMES	18		
URSL	111	SINGLE FAMILY LOW DENSITY	15		
URSM	121	SINGLE FAMILY MEDIUM DENSITY	291		
TOTAL AREA			2943		100.00

1979 LAND USE/LAND COVER DATA

S-236 Basin

SFWMD	DOT		ACREAGE	SUB-TOTAL	PERCENT
ACSC	216	SUGAR CANE	8243		
ACTC	214	TRUCK CROPS	56	10296	97.07
APIM	211	IMPROVED PASTURE	1997		
BL	744	LEVEES	36	36	.34
UI	150	INDUSTRIAL	31		
UOUN	191	OPEN AND UNDEVELOPED	3		
URMF	134	MULTI-FAMILY	43	275	2.59
URSL	111	SINGLE FAMILY LOW DENSITY	163		
URSM	121	SINGLE FAMILY MEDIUM DENSITY	35		
TOTAL AREA			10607		100.00

1979 LAND USE/LAND COVER DATA

S-2 Basin

SFWMD	DOT		ACREAGE	SUB-TOTAL	PERCENT
ACSC	216	SUGAR CANE	96621		
ACTC	214	TRUCK CROPS	3936	101722	95.99
AMCT	221	CITRUS	19		
APIM	211	IMPROVED PASTURE	1146		
BP	742	EXTRACTIVE	26	26	.02
H	500	WATER	150	575	.54
HC	510	RIVERS, STREAMS, CANALS	425		
UCCE	144	CULTURAL & ENTERTAINMENT	22		
UCSS	141	SALES & SERVICES	155		
UI	150	INDUSTRIAL	493		
UOCM	148	CEMETERIES	24		
UOGC	182	GOLF COURSE	61		
UOUD	193	OPEN UNDER DEVELOPMENT	51		
UOUN	191	OPEN AND UNDEVELOPED	277		
URMF	134	MULTI-FAMILY	49		
URMH	122	MOBILE HOMES	173		
URSL	111	SINGLE FAMILY LOW DENSITY	456	3651	3.45
URSM	121	SINGLE FAMILY MEDIUM DENSITY	1321		
USCF	176	CORRECTIONAL FACILITY	70		
USED	171	EDUCATIONAL FACILITY	227		
USGF	175	OTHER GOVERNMENTAL	23		
USMD	174	MEDICAL FACILITY	16		
USMF	173	MILITARY FACILITY	3		
USRL	172	RELIGIOUS	2		
UTAG	811	SMALL GRASS AIRPORT	76		
UTRS	821	BROADCASTING OR RECEIVING TOWERS	7		
UTSP	834	SEWERAGE TREATMENT FACILITY	32		
UTSW	835	SOLID WASTE DISPOSAL	113		
TOTAL AREA			105974		100.00

1979 LAND USE/LAND COVER DATA

S-3 Basin

SFWMD	DOT		ACREAGE	SUB-TOTAL	PERCENT
ACSC	216	SUGAR CANE	57380		
ACTC	214	TRUCK CROPS	3030	64183	99.27
APIM	211	IMPROVED PASTURE	3773		
BL	744	LEVEES	45	45	.07
H	500	WATER	9		
HC	510	RIVERS, STREAMS, CANALS	162	171	.26
UI	150	INDUSTRIAL	14		
UOPK	185	PARKS	39		
UOUN	191	OPEN AND UNDEVELOPED	61	259	.40
URSL	111	SINGLE FAMILY LOW DENSITY	84		
URSM	121	SINGLE FAMILY MEDIUM DENSITY	56		
UTRS	821	BROADCASTING OR RECEIVING TOWERS	5		
TOTAL AREA			64658		100.00

1979 LAND USE/LAND COVER DATA

S-4 Basin

SFWMD	DOT		ACREAGE	SUB-TOTAL	PERCENT
ACSC	216	SUGAR CANE	17123		
ACTC	214	TRUCK CROPS	211		
AFDF	252	DAIRY FARMS	39	37398	88.16
AFFL	231	CATTLE FEED LOTS	167		
AMOR	243	ORNAMENTALS	27		
APIM	211	IMPROVED PASTURE	19831		
BL	744	LEVEES	285	448	1.06
BP	742	EXTRACTIVE	163		
FOAP	414	AUSTRALIAN PINES	67	67	.15
H	500	WATER	43	91	.21
HO	520	OPEN FRESH WATER	48		
UCMC	184	MARINAS & BOATYARDS	17		
UCSS	141	SALES & SERVICES	97		
UIJK	141	JUNKYARDS & AUTO SALVAGE	9		
UI	150	INDUSTRIAL	342		
UOCM	148	CEMETERIES	23		
UOGC	182	GOLF COURSE	151		
UOPK	185	PARKS	94		
UORC	186	RECREATIONAL FACILITY	9		
UOUN	191	OPEN AND UNDEVELOPED	209		
URMF	134	MULTI-FAMILY	66	2901	6.84
URMH	122	MOBILE HOMES	153		
URSL	111	SINGLE FAMILY LOW DENSITY	612		
URSM	121	SINGLE FAMILY MEDIUM DENSITY	843		
USED	171	EDUCATIONAL FACILITY	97		
USGF	175	OTHER GOVERNMENTAL	24		
USMD	174	MEDICAL FACILITY	10		
USRL	172	RELIGIOUS	9		
UTAG	811	SMALL GRASS AIRPORT	129		
UTRS	821	BROADCASTING OR RECEIVING TOWERS	2		
UTWS	833	WATER SUPPLY FACILITY	5		
WFMX	630	MIXED FORESTED	117		
WFWL	610	WILLOW	679	1517	3.58
WN	640	NON-FORESTED FRESH	721		
TOTAL AREA			42422		100.00

1980 LAND USE/LAND COVER DATA

Fisheating Creek Basin

SFWMD	DOT		ACREAGE	SUB-TOTAL	PERCENT
AFDF	252	DAIRY FARMS	56		
AMCT	221	CITRUS	3508		
AMOR	243	ORNAMENTALS	29	91408	28.34
APIM	211	IMPROVED PASTURE	80280		
APUN	212	UNIMPROVED PASTURE	7535		
BL	744	LEVEES	70	83	.04
BP	742	EXTRACTIVE	13		
FECF	441	COMMERCIAL FOREST (PINE)	18786		
FEPF	411	PINE FLATWOODS	26517		
FMCO	432	CABBAGE PALMS/OAKS	3453		
FMOF	740	OLD FIELDS FORESTED	111	64752	21.55
FMPC	419	PINE/CABBAGE PALM	4522		
FMPO	415	PINE/OAK	10459		
FMTW	425	TEMPERATE HARDWOODS	27		
FOOK	425	OAK	877		
H	500	WATER	324	613	.21
HC	510	RIVERS, STREAMS, CANALS	289		
RG	310	GRASSLAND	273	84439	28.53
RSPP	321	PALMETTO PRAIRIES	84166		
UCSS	141	SALES & SERVICES	10		
UI	150	INDUSTRIAL	5		
UORC	186	RECREATIONAL FACILITY	24		
UOUD	193	OPEN UNDER DEVELOPMENT	751		
UOUN	191	OPEN AND UNDEVELOPED	94	2022	.69
URSL	111	SINGLE FAMILY LOW DENSITY	1024		
URSM	121	SINGLE FAMILY MEDIUM DENSITY	74		
UTAG	811	SMALL GRASS AIRPORT	39		
UTRS	821	BROADCASTING OR RECEIVING TOWERS	1		
WFCY	621	CYPRESS	13693		
WFME	424	MELALEUCA	210		
WFMX	630	MIXED FORESTED	3435	52646	17.79
WNWL	641	SLOUGHS	4915		
WN	640	NON-FORESTED FRESH	29985		
WXCP	643	CYPRESS & WET PRAIRIES	408		
TOTAL AREA			295963		100.00

1980 LAND USE/LAND COVER DATA

S-127 Basin

SFWMD	DOT		ACREAGE	SUB-TOTAL	PERCENT
AFDF	252	DAIRY FARMS	20	17595	84.73
APIM	211	IMPROVED PASTURE	17575		
BS	743	SPOIL AREAS	266	266	1.28
FMCO	432	CABBAGE PALMS/OAKS	5	5	.02
H	500	WATER	7	194	.94
HC	510	RIVERS, STREAMS, CANALS	187		
RG	310	GRASSLAND	57	139	.67
RSPP	321	PALMETTO PRAIRIES	82		
UOUD	193	OPEN UNDER DEVELOPMENT	100	569	2.74
UOUN	191	OPEN AND UNDEVELOPED	91		
URMH	122	MOBILE HOMES	351		
URSL	111	SINGLE FAMILY LOW DENSITY	27		
WN	640	NON-FORESTED FRESH	1998	1998	9.62
TOTAL AREA			20766		100.00

1980 LAND USE/LAND COVER DATA

S-129 Basin

SFWMD	DOT		ACREAGE	PERCENT
APIM	211	IMPROVED PASTURE	11333	93.61
BL	744	LEVEES	209	1.72
FMCO	432	CABBAGE PALMS/OAKS	50	.42
HC	510	RIVERS, STREAMS, CANALS	180	1.49
URSH	131	SINGLE FAMILY HIGH DENSITY	334	2.76
TOTAL AREA			12106	100.00

1980 LAND USE/LAND COVER DATA

S-131 Basin

SFWMD	DOT		ACREAGE	SUB-TOTAL	PERCENT
AFFF	254	FISH FARMS	6	6382	88.97
APIM	211	IMPROVED PASTURE	6376		
BL	744	LEVEES	91	149	2.08
BP	742	EXTRACTIVE	58		
FMCO	432	CABBAGE PALMS/OAKS	78	78	1.09
H	500	WATER	13	187	2.60
HC	510	RIVERS, STREAMS, CANALS	174		
UOUN	191	OPEN AND UNDEVELOPED	14	363	5.06
URMH	122	MOBILE HOMES	15		
URSL	111	SINGLE FAMILY LOW DENSITY	334		
WFWL	610	WILLOW	3	14	.20
WNCT	641	CATTAIL	11		
TOTAL AREA			7173		100.00

1980 LAND USE/LAND COVER DATA

S-71/Harney Pond Basin

SFWMD	DOT		ACREAGE	SUB-TOTAL	PERCENT
ACTC	214	TRUCK CROPS	468		
AFDF	252	DAIRY FARMS	27		
AMCT	221	CITRUS	8812	76845	68.32
AMOR	243	ORNAMENTALS	1575		
APIM	211	IMPROVED PASTURE	56871		
APUN	212	UNIMPROVED PASTURE	9092		
BL	744	LEVEES	72	72	.06
FEPF	411	PINE FLATWOODS	1945		
FMCO	432	CABBAGE PALMS/OAKS	5701		
FMPO	415	PINE/OAK	1446	15600	13.87
FMTW	425	TEMPERATE HARDWOODS	4623		
FOOK	425	OAK	1885		
H	500	WATER	575	950	.85
HC	510	RIVERS, STREAMS, CANALS	375		
RSPP	321	PALMETTO PRAIRIES	12023	14015	12.46
RSSB	329	OTHER SCRUB & BRUSHLAND	1992		
UCSS	141	SALES & SERVICES	6		
UI	150	INDUSTRIAL	11		
UORC	186	RECREATIONAL FACILITY	28		
UOUD	193	OPEN UNDER DEVELOPMENT	1590		
UOUN	191	OPEN AND UNDEVELOPED	369	2418	2.15
URMH	122	MOBILE HOMES	42		
URSL	111	SINGLE FAMILY LOW DENSITY	281		
URSM	121	SINGLE FAMILY MEDIUM DENSITY	82		
USGF	175	OTHER GOVERNMENTAL	5		
UTEP	831	ELECTRICAL POWER FACILITY	4		
WFCY	621	CYPRESS	15	2582	2.29
WN	640	NON-FORESTED FRESH	2567		
TOTAL AREA			112482		100.00

1980 LAND USE/LAND COVER DATA

S-72/Indian Prairie Basin

SFWMD	DOT		ACREAGE	SUB-TOTAL	PERCENT
ACTC	214	TRUCK CROPS	337		
AMCT	221	CITRUS	2689	44459	80.26
APIM	211	IMPROVED PASTURE	37754		
APUN	212	UNIMPROVED PASTURE	3679		
BL	744	LEVEES	56	56	.10
FMCO	432	CABBAGE PALMS/OAKS	6099	6113	11.04
FOAP	414	AUSTRALIAN PINES	14		
HC	510	RIVERS, STREAMS, CANALS	192	192	.35
RSPP	321	PALMETTO PRAIRIES	47	47	.08
UCSS	141	SALES & SERVICES	4	57	.10
URSL	111	SINGLE FAMILY LOW DENSITY	53		
WN	640	NON-FORESTED FRESH	4473	4473	8.07
TOTAL AREA			55397		100.00

1980 LAND USE/LAND COVER DATA

S-84 Basin

SFWMD	DOT		ACREAGE	SUB-TOTAL	PERCENT
APIM	211	IMPROVED PASTURE	19243	19243	33.38
BL	744	LEVEES	747	747	1.30
FEPF	411	PINE FLATWOODS	1069		
FMCO	432	CABBAGE PALMS/OAKS	1313		
FMTW	425	TEMPERATE HARDWOODS	316	2755	4.78
FOAP	414	AUSTRALIAN PINES	5		
FOOK	425	OAK	52		
H	500	WATER	73	282	.49
HC	510	RIVERS, STREAMS, CANALS	209		
RSPP	321	PALMETTO PRAIRIES	28059	28059	48.67
URSL	111	SINGLE FAMILY LOW DENSITY	10	10	.01
WN	640	NON-FORESTED FRESH	6558	6558	11.37
TOTAL AREA			57654		100.00

1980 LAND USE/LAND COVER DATA

Lower Kissimmee Basin

SFWMD	DOT		ACREAGE	SUB-TOTAL	PERCENT
AFDF	252	DAIRY FARMS	88	8745	60.83
APIM	211	IMPROVED PASTURE	8657		
BL	744	LEVEES	1054	1490	10.37
BS	743	SPOIL AREAS	436		
FMCO	432	CABBAGE PALMS/OAKS	336	336	2.33
HC	510	RIVERS, STREAMS, CANALS	630	630	4.39
RSPP	321	PALMETTO PRAIRIES	384	384	2.68
UOPK	185	PARKS	68	99	.69
UOUN	191	OPEN AND UNDEVELOPED	14		
URSL	111	SINGLE FAMILY LOW DENSITY	17		
WN	640	NON-FORESTED FRESH	2689	2689	18.71
TOTAL AREA			14373		100.00

1980 LAND USE/LAND COVER DATA

S-154 Basin

SFWMD	DOT		ACREAGE	SUB-TOTAL	PERCENT
AFDF	252	DAIRY FARMS	18		
AFFL	231	CATTLE FEED LOTS	47	18558	78.86
APIM	211	IMPROVED PASTURE	18493		
BL	744	LEVEES	175	180	.77
BP	742	EXTRACTIVE	5		
FEPF	411	PINE FLATWOODS	81		
FMCO	432	CABBAGE PALMS/OAKS	88	1564	6.65
FMPC	419	PINE/CABBAGE PALM	236		
RSPP	321	PALMETTO PRAIRIES	1159		
UCSS	141	SALES & SERVICES	14		
UI	150	INDUSTRIAL	4		
UOUD	193	OPEN UNDER DEVELOPMENT	119		
UOUN	191	OPEN AND UNDEVELOPED	1	2775	11.80
URSL	111	SINGLE FAMILY LOW DENSITY	1187		
URSM	121	SINGLE FAMILY MEDIUM DENSITY	1136		
UTAP	811	AIRPORTS	314		
WFMX	630	MIXED FORESTED	243	455	1.92
WN	640	NON-FORESTED FRESH	212		
TOTAL AREA			23532		100.00

1980 LAND USE/LAND COVER DATA

S-133/Lower Taylor Creek Basin

SFWMD	DOT		ACREAGE	SUB-TOTAL	PERCENT
AMCT	221	CITRUS	162		
AMOR	243	ORNAMENTALS	4	16094	62.69
APIM	211	IMPROVED PASTURE	15600		
APUN	212	UNIMPROVED PASTURE	328		
BL	744	LEVEES	406	908	3.54
BP	742	EXTRACTIVE	502		
FEPF	411	PINE FLATWOODS	258		
FMCO	432	CABBAGE PALMS/OAKS	911	1676	6.53
FMPC	419	PINE/CABBAGE PALM	319		
FOOK	425	OAK	188		
H	500	WATER	160	378	1.47
HC	510	RIVERS, STREAMS, CANALS	218		
UCCE	144	CULTURAL & ENTERTAINMENT	35		
UCMC	184	MARINAS & BOATYARDS	16		
UCSC	141	SHOPPING CENTER	41		
UCSS	141	SALES & SERVICES	274		
UI	150	INDUSTRIAL	40		
UOPK	185	PARKS	17		
UORC	186	RECREATIONAL FACILITY	13		
UOUD	193	OPEN UNDER DEVELOPMENT	395		
UOUN	191	OPEN AND UNDEVELOPED	342		
URMF	134	MULTI-FAMILY	234		
URMH	122	MOBILE HOMES	979	5708	22.23
URSH	131	SINGLE FAMILY HIGH DENSITY	50		
URSL	111	SINGLE FAMILY LOW DENSITY	938		
URSM	121	SINGLE FAMILY MEDIUM DENSITY	1565		
USED	171	EDUCATIONAL FACILITY	161		
USGF	175	OTHER GOVERNMENTAL	22		
USMD	174	MEDICAL FACILITY	24		
UTAP	811	AIRPORTS	526		
UTEP	831	ELECTRICAL POWER FACILITY	14		
UTRS	821	BROADCASTING OR RECEIVING TOWERS	18		
UTWS	833	WATER SUPPLY FACILITY	4		
WFCY	621	CYPRESS	768		
WFMX	630	MIXED FORESTED	31	910	3.54
WNCT	641	CATTAIL	24		
WN	640	NON-FORESTED FRESH	87		
TOTAL AREA			25674		100.00

1980 LAND USE/LAND COVER DATA

Upper Taylor Creek Basin

SFWMD	DOT		ACREAGE	SUB-TOTAL	PERCENT
AFDF	252	DAIRY FARMS	135	48499	72.61
AFFL	231	CATTLE FEED LOTS	200		
AFHT	251	HORSE TRAINING	7		
AMCT	221	CITRUS	1796		
APIM	211	IMPROVED PASTURE*	46358		
APUN	212	UNIMPROVED PASTURE	3		
FECF	441	COMMERCIAL FOREST (PINE)	37	3912	5.86
FEPF	411	PINE FLATWOODS	866		
FMCO	432	CABBAGE PALMS/OAKS	1377		
FMPC	419	PINE/CABBAGE PALM	712		
FMPO	415	PINE/OAK	273		
FMTW	425	TEMPERATE HARDWOODS	647		
H	500	WATER	34	34	.05
RSPP	321	PALMETTO PRAIRIES	6485	6485	9.71
UCSS	141	SALES & SERVICES	5	3164	4.74
UOGC	182	GOLF COURSE	71		
UOUD	193	OPEN UNDER DEVELOPMENT	317		
URMF	134	MULTI-FAMILY	61		
URMH	122	MOBILE HOMES	26		
URSL	111	SINGLE FAMILY LOW DENSITY	2399		
URSM	121	SINGLE FAMILY MEDIUM DENSITY	46		
USCF	176	CORRECTIONAL FACILITY	221		
USGF	175	OTHER GOVERNMENTAL	8		
USRL	172	RELIGIOUS	3		
UTAG	811	SMALL GRASS AIRPORT	7		
WFCY	621	CYPRESS	355	4699	7.03
WFMX	630	MIXED FORESTED	3796		
WN	640	NON-FORESTED FRESH	548		
TOTAL AREA			66793		100.00

*Includes beef and dairy pasture

1980 LAND USE/LAND COVER DATA

Nubbin Slough Basin

SFWMD	DOT		ACREAGE	SUB-TOTAL	PERCENT
ACTC	214	TRUCK CROPS	444		
AFDF	252	DAIRY FARMS	152		
AFFL	231	CATTLE LOTS	34	36537	67.99
AMCT	221	CITRUS	8		
APIM	211	IMPROVED PASTURE*	35899		
BL	744	LEVEES	13	13	.03
FEPF	411	PINE FLATWOODS	489		
FMCO	432	CABBAGE PALMS/OAKS	2072	4604	8.56
FMOF	740	OLD FIELDS FORESTED	435		
FMPC	419	PINE/CABBAGE PALM	1608		
HC	510	RIVERS, STREAMS, CANALS	177	190	.35
HO	520	OPEN FRESH WATER	13		
RS	320	SCRUB & BRUSHLAND	124	124	
UOCM	148	CEMETERIES	53		
UOUD	193	UNDER DEVELOPMENT	22		
URMH	122	MOBILE HOMES	49	638	1.42
URSL	111	SINGLE FAMILY LOW DENSITY	455		
URSM	121	SINGLE FAMILY MEDIUM DENSITY	41		
USED	171	EDUCATIONAL	18		
WFCY	621	CYPRESS	266		
WFMX	630	MIXED FORESTED	354	11636	21.65
WN	640	NON-FORESTED FRESH	823		
WXPP	643	PINE & WET PRAIRIES	10193		
TOTAL AREA			53742		100.00

*Includes beef and dairy pasture

1980 LAND USE/LAND COVER DATA

S-135 Basin

SFWMD	DOT		ACREAGE	SUB-TOTAL	PERCENT
ACSC	216	SUGAR CANE	4507		
AFDF	252	DAIRY FARMS	15	13751	75.99
AMCT	221	CITRUS	61		
APIM	211	IMPROVED PASTURE	9168		
BL	744	LEVEES	746	746	4.12
FEPF	411	PINE FLATWOODS	509		
FMCO	432	CABBAGE PALMS/OAKS	1024	1781	9.84
FMPC	419	PINE/CABBAGE PALM	123		
FMPO	415	PINE/OAK	125		
H	500	WATER	687	723	4.00
HC	510	RIVERS, STREAMS, CANALS	36		
UCSS	141	SALES & SERVICES	7		
UOUN	191	OPEN AND UNDEVELOPED	26	340	1.88
URMH	122	MOBILE HOMES	196		
URSL	111	SINGLE FAMILY LOW DENSITY	111		
WFCY	621	CYPRESS	155		
WN	640	NON-FORESTED FRESH	23	754	4.17
WXPP	643	PINE & WET PRAIRIES	576		
TOTAL AREA			18095		100.00

1981 LAND USE/LAND COVER DATA

S-65A Basin

SFWMD	DOT		ACREAGE	SUB-TOTAL	PERCENT
ACTC	214	TRUCK CROPS	2491		
AFFL	231	CATTLE FEED LOTS	42		
AMCT	221	CITRUS	1179	48130	46.61
APIM	211	IMPROVED PASTURE	42608		
APUN	212	UNIMPROVED PASTURE	1810		
BS	743	SPOIL AREAS	1245	1245	1.20
FECF	441	COMMERCIAL FOREST (PINE)	4699		
FEPF	411	PINE FLATWOODS	7966		
FESP	413	SAND PINE SCRUB	437		
FMCO	432	CABBAGE PALMS/OAKS	598		
FMPC	419	PINE/CABBAGE PALM	39	14222	13.77
FMPO	415	PINE/OAK	8		
FMTH	426	TROPICAL HAMMOCKS	24		
FOAP	414	AUSTRALIAN PINES	14		
FOOK	425	OAK	437		
H	500	WATER	114	114	.11
RG	310	GRASSLAND	1055		
RS	320	SCRUB AND BRUSHLAND	617	31527	30.53
RSPP	321	PALMETTO PRAIRIES	28726		
RSSB	329	OTHER SCRUB AND BRUSHLAND	1129		
U	100	URBAN & BUILT-UP LAND	14		
UCHM	145	HOTEL-MOTEL	101		
UCMC	184	MARINAS & BOATYARDS	6		
UOGC	182	GOLF COURSE	166		
UOUD	193	OPEN UNDER DEVELOPMENT	80	458	.44
URMH	122	MOBILE HOMES	35		
URSL	111	SINGLE FAMILY LOW DENSITY	6		
UTAP	811	AIRPORTS	50		
WFCY	621	CYPRESS	880		
WFMX	630	MIXED FORESTED	158		
WFSB	610	SCRUB AND BRUSHLAND	511		
WFWL	610	WILLOW	549	7576	7.34
WNAG	641	MIXED AQUATIC GRASS	935		
WNWC	641	WIRE CORDGRASS	117		
WNWL	641	SLOUGHS	192		
WN	640	NON-FORESTED FRESH	4234		
TOTAL AREA			103272		100.00

1981 LAND USE/LAND COVER DATA

S-65B Basin

SFWMD	DOT		ACREAGE	SUB-TOTAL	PERCENT
ACTC	214	TRUCK CROPS	2316		
AMCT	221	CITRUS	481	25563	19.92
APIM	211	IMPROVED PASTURE	20965		
APUN	212	UNIMPROVED PASTURE	1801		
BL	744	LEVEES	118	1293	1.01
BS	743	SPOIL AREAS	1175		
FECF	441	COMMERCIAL FOREST (PINE)	3317		
FEPF	411	PINE FLATWOODS	3322		
FESP	413	SAND PINE SCRUB	497		
FMCO	432	CABBAGE PALMS/OAKS	1159	11387	8.87
FMPC	419	PINE/CABBAGE PALM	116		
FMPO	415	PINE/OAK	428		
FOOK	425	OAK	2548		
H	500	WATER	976	976	.76
RG	310	GRASSLAND	9955		
RSPP	321	PALMETTO PRAIRIES	57826	68797	53.62
RSSB	329	OTHER SCRUB & BRUSHLAND	1016		
U	100	URBAN & BUILT-UP LAND	4	1919	1.50
USMF	173	MILITARY FACILITY	1915		
WFCY	621	CYPRESS	733		
WFMX	630	MIXED FORESTED	428		
WFSB	610	SCRUB & BRUSHLAND	252		
WFWL	610	WILLOW	414		
WNAG	641	MIXED AQUATIC GRASS	1267	18373	14.32
WNSG	641	SAWGRASS	77		
WNWC	641	WIRE CORDGRASS	216		
WNWL	641	SLOUGHS	2319		
WN	640	NON-FORESTED FRESH	12667		
TOTAL AREA			128308		100.00

1981 LAND USE/LAND COVER DATA

S-65C Basin

SFWMD	DOT		ACREAGE	SUB-TOTAL	PERCENT
AFFL	231	CATTLE FEED LOTS	19		
APIM	211	IMPROVED PASTURE	31025	33046	65.49
APUN	212	UNIMPROVED PASTURE	2002		
BL	744	LEVEES	76	1034	2.05
BS	743	SPOIL AREAS	958		
FEPF	411	PINE FLATWOODS	418		
FMCO	432	CABBAGE PALMS/OAKS	379	2536	5.03
FMTW	425	TEMPERATE HARDWOODS	208		
FOOK	425	OAK	1531		
H	500	WATER	837	837	1.66
RSPP	321	PALMETTO PRAIRIES	6290	7071	14.01
RSSB	329	OTHER SCRUB & BRUSHLAND	781		
U	100	URBAN & BUILT-UP LAND	12	12	.02
WFCY	621	CYPRESS	40		
WFSB	610	SCRUB & BRUSHLAND	372		
WFWL	610	WILLOW	430		
WNAG	641	MIXED AQUATIC GRASS	1097	5923	11.74
WNWC	641	WIRE CORDGRASS	59		
WNWL	641	SLOUGHS	1167		
WN	640	NON-FORESTED FRESH	2758		
TOTAL AREA			50459		100.00

1981 LAND USE/LAND COVER DATA

S-65D Basin

SFWMD	DOT		ACREAGE	SUB-TOTAL	PERCENT
AFDF	252	DAIRY FARMS	47		
AFFL	231	CATTLE FEED LOTS	57		
AMCT	221	CITRUS	175	73155	62.74
AMSF	242	SOD FARMS	672		
APIM	211	IMPROVED PASTURE	71616		
APUN	212	UNIMPROVED PASTURE	588		
BL	744	LEVEES	134	1182	1.02
BS	743	SPOIL AREAS	1048		
FEPF	411	PINE FLATWOODS	3110		
FMCO	432	CABBAGE PALMS/OAKS	1041		
FMOF	740	OLD FIELDS FORESTED	64	7001	6.00
FMPC	419	PINE/CABBAGE PALM	222		
FMTW	425	TEMPERATE HARDWOODS	870		
FOOK	425	OAK	1694		
H	500	WATER	830	830	.71
RG	310	GRASSLAND	56		
RSPP	321	PALMETTO PRAIRIES	24733	25535	21.90
RSSB	329	OTHER SCRUB & BRUSHLAND	746		
U	100	URBAN & BUILT-UP LAND	110		
URSL	111	SINGLE FAMILY LOW DENSITY	89		
URSM	121	SINGLE FAMILY MEDIUM DENSITY	14	269	.23
UTAG	811	SMALL GRASS AIRPORT	41		
UTAP	811	AIRPORTS	15		
WFCY	621	CYPRESS	1792		
WFSB	610	SCRUB & BRUSHLAND	500		
WFWL	610	WILLOW	214		
WNAG	641	MIXED AQUATIC GRASS	306	8628	7.40
WNWC	641	WIRE CORDGRASS	84		
WNWL	641	SLOUGHS	654		
WN	640	NON-FORESTED FRESH	4956		
WXHM	643	HARDWOOD & MARSH	122		
TOTAL AREA			116600		100.00

1981 LAND USE/LAND COVER DATA

S-65E Basin

SFWMD	DOT		ACREAGE	SUB-TOTAL	PERCENT
ACTC	214	TRUCK CROPS	621		
AFDF	252	DAIRY FARMS	26		
AFFL	231	CATTLE FEED LOTS	37	27526	69.84
AMCT	221	CITRUS	13		
APIM	211	IMPROVED PASTURE	26586		
APUN	212	UNIMPROVED PASTURE	243		
BL	744	LEVEES	42	1033	2.62
BS	743	SPOIL AREAS	991		
FEPF	411	PINE FLATWOODS	424		
FMCO	432	CABBAGE PALMS/OAKS	1756	4305	10.92
FMPC	419	PINE/CABBAGE PALM	1129		
FOOK	425	OAK	996		
H	500	WATER	755	755	1.92
RSPP	321	PALMETTO PRAIRIES	3304	4125	10.47
RSSB	329	OTHER SCRUB & BRUSHLAND	821		
U	100	URBAN & BUILT-UP LAND	37		
URSL	111	SINGLE FAMILY LOW DENSITY	362	487	1.23
URSM	121	SINGLE FAMILY MEDIUM DENSITY	81		
UTHW	814	MAJOR HIGHWAYS & RIGHTS-OF-WAYS	7		
WFCY	621	CYPRESS	12		
WFMX	630	MIXED FORESTED	26		
WFSB	610	SCRUB & BRUSHLAND	6		
WFWL	610	WILLOW	50		
WNAG	641	MIXED AQUATIC GRASS	147	1183	3.00
WNWL	641	SLOUGHS	197		
WN	640	NON-FORESTED FRESH	526		
WXPP	643	PINE & WET PRAIRIES	219		
TOTAL AREA			39414		100.00

Land Use/Land Cover - Included in the Categories Used for Loading Analysis

Low Intensity Land Uses (Urban)

Open Under Development
Open and Undeveloped
Multi-Family
Mobile Homes
Single Family - Low & Medium Density
Small Grass Airport
Airport
Broadcasting or Receiving Towers
Parks
Recreational Facility
Military Facility[1]
Urban and Built-up Land

Uplands

Unimproved Pasture
Commercial Forest (Pine)
Pine Flatwoods
Cabbage Palm/Oaks
Old Fields Forested
Pine/Cabbage Palm
Pine/Oak
Temperate Hardwoods
Oak
Grassland
Palmetto Prairies
Other Scrubland and Brushland
Sand Pine Scrub
Tropical Hammocks
Australian Pine

High Intensity Land Uses (Urban)

Cultural & Entertainment
Sales & Services
Industrial
Correctional Facility
Educational Facility
Other Governmental
Medical Facility
Military Facility
Religious
Junkyards & Auto Salvage
Water Supply Facility
Electrical Power Facility
Major Highways & Rights-of-way
Hotel - Motel
Marinas & Boatyards
Cemetaries

Wetlands

Cypress
Melaleuca
Mixed Forested
Sloughs
Non-forested Fresh
Cypress and Wet Prairies
Pine and Wet Prairies
Mixed Aquatic Grass
Willow
Wire Cordgrass
Sawgrass
Hardwood and Marsh

[1]Avon Park Bombing Range

Watershed: Taylor Creek/Nubbin Slough (S-191)

Land Use	Acres	Total P Load, lb/yr	Total N Load, lb/yr
Low Intensity Urban	3,487	5,580	20,573
High Intensity Urban	315	756	3,780
Crops, Sod	444	844	14,741
Sugarcane	0	0	0
Citrus	1,804	361	7,216
Intensely Managed Dairy Pasture	10,000	153,000	387,000
Dairy, Feedlots	21,458	90,124	193,122
Improved Pasture (beef)	51,327	76,991	307,962
Uplands	15,128	756	16,641
Wetlands	16,335	2,940	80,042
	120,298	331,352 (166 tons)	1,031,077 (516 tons)

Watershed: S-2

Land Use	Acres	Total P Load, lb/yr	Total N Load, lb/yr
Low Intensity Urban	2,471	3,954	14,579
High Intensity Urban	1,180	2,832	14,160
Crops, Sod	3,936	7,478	130,675
Sugarcane	96,621	57,973	2,338,228
Citrus	19	4	76
Dairy, Feedlots	0	0	0
Improved Pasture	1,146	573	10,543
Uplands	0	0	0
Wetlands	0	0	0
	105,373	72,814 (36 tons)	2,508,261 (1,254 tons)

	Flow, MGD	Total P Load, lb/yr	Total N Load, lb/yr
Wastewater treatment plants	2.0	42,617	121,764
TOTAL		115,431 (58 tons)	2,630,025 (1,315 tons)

C-38 Land Uses

Land Use	S-65A	S-65B	S-65C	S-65D	S-65E	Total
Low Intensity Urban	351	1,919	12	269	480	3,031
High Intensity Urban	101	0	0	0	7	108
Crops, Sod	2,491	2,316	0	672	621	6,100
Sugarcane	0	0	0	0	0	0
Citrus	1,179	481	0	175	13	1,848
Dairy, Feedlots	42	0	19	104	63	228
Improved Pasture	42,608	20,965	31,025	71,616	26,586	192,800
Uplands	47,559	81,985	11,609	33,124	8,673	182,950
Wetlands	7,576	18,373	5,923	8,628	1,183	41,683
	101,907	126,039	14,588	114,588	37,626	428,748

Watershed: C-38 Basin (S-65A, B, C, D, E)

Land Use	Acres	Total P Load, lb/yr	Total N Load, lb/yr
Low Intensity Urban	3,031	4,850	17,883
High Intensity Urban	108	259	1,296
Crops, Sod	6,100	11,590	202,520
Sugarcane	0	0	0
Citrus	1,848	370	7,392
Dairy, Feedlots	228	958	2,052
Improved Pasture	192,800	289,200	1,156,800
Uplands	182,950	9,148	201,245
Wetlands	41,683	7,503	204,247
	428,748	323,878 (162 tons)	1,793,435 (897 tons)

Watershed: Harney Pond Basin (S-71)

Land Use	Acres	Total P Load, lb/yr	Total N Load, lb/yr
Low Intensity Urban	2,392	3,827	14,113
High Intensity Urban	26	62	312
Crops, Sod	468	889	15,538
Sugarcane	0	0	0
Citrus	10,387	2,077	41,548
Dairy, Feedlots	27	113	243
Improved Pasture	56,871	85,307	344,226
Uplands	38,707	1,935	42,578
Wetlands	2,582	465	12,652
	111,460	94,675 (47 tons)	468,210 (234 tons)

Watershed: S-3

Land Use	Acres	Total P Load, lb/yr	Total N Load, lb/yr
Low Intensity Urban	245	392	1,446
High Intensity Urban	14	34	168
Crops, Sod	3,030	5,757	100,596
Sugarcane	57,380	34,428	1,388,596
Citrus	0	0	0
Dairy, Feedlots	0	0	0
Improved Pasture	3,773	1,887	34,712
Uplands	0	0	0
Wetlands	0	0	0
	64,442	42,498 (21 tons)	1,525,518 (763 tons)

Watershed: Fisheating Creek

Land Use	Acres	Total P Load, lb/yr	Total N Load, lb/yr
Low Intensity Urban	2,007	3,211	11,841
High Intensity Urban	15	36	180
Crops, Sod	0	0	0
Sugarcane	0	0	0
Citrus	3,537	707	14,148
Dairy, Feedlots	56	235	504
Improved Pasture	80,280	120,420	481,680
Uplands	156,726	7,836	172,399
Wetlands	52,646	9,476	257,965
	295,267	141,921 (71 tons)	938,717 (469 tons)

Watershed: S-4

Land Use	Acres	Total P Load, lb/yr	Total N Load, lb/yr
Low Intensity Urban	2,291	3,666	13,517
High Intensity Urban	593	1,423	7,116
Crops, Sod	211	401	7,005
Sugarcane	17,123	10,274	414,377
Citrus	27	5	108
Dairy, Feedlots	206	865	1,854
Improved Pasture	19,831	29,747	118,986
Uplands	67	3	74
Wetlands	1,517	273	7,433
	41,866	46,657 (23 tons)	570,470 (285 tons)

Land Use/Loading Analysis

Watershed: Taylor Creek/Nubbin Slough (S-191)

Land Use	% of Watershed	% of Total P Load	% of Total N Load
Dairy, Pasture	26.2	73.4	56.3
Improved Pasture	42.3	23.2	29.9
Urban	3.2	1.9	2.4
Wetlands	13.6	0.9	7.8
Other	14.7	0.6	3.6

Land Use/Loading Analysis

Watershed: S-2

Land Use	% of Watershed	% of Total P Load	% of Total N Load
Sugarcane	91.7	50.2	88.9
Point Sources	-	36.9	4.6
Crops, Sod	3.7	6.5	4.5
Urban	3.5	5.9	1.1
Other	1.1	0.5	0.9

Land Use/Loading Analysis

Watershed: C-38 Basin (S-65A, B, C, D, E)

Land Use	% of Watershed	% of Total P Load	% of Total N Load
Improved Pasture	45.0	89.3	64.5
Crops, Sod	1.4	3.6	11.3
Uplands	42.7	2.8	11.2
Wetlands	9.7	2.3	11.4
Urban	0.7	1.6	1.1
Other	0.5	0.4	0.5

Land Use/Loading Analysis

Watershed: Harney Pond Basin (S-71)

Land Use	% of Watershed	% of Total P Load	% of Total N Load
Improved Pasture	51.0	90.1	72.8
Urban	2.2	4.1	3.1
Citrus	9.3	2.2	8.9
Uplands	34.7	2.0	9.1
Crops, Sod	0.4	0.9	3.3
Wetlands	2.3	0.5	2.7
Other	0.1	0.2	0.1

Land Use/Loading Analysis

Watershed: S-3

Land Use	% of Watershed	% of Total P Load	% of Total N Load
Sugarcane	89.0	81.0	91.0
Crops, Sod	4.7	13.5	6.6
Improved Pasture	5.9	4.4	2.3
Other	0.4	1.1	0.1

Land Use/Loading Analysis

Watershed: Fisheating Creek

Land Use	% of Watershed	% of Total P Load	% of Total N Load
Improved Pasture	27.2	84.9	51.3
Wetlands	17.8	6.7	25.5
Uplands	53.0	5.5	18.4
Urban	0.7	2.3	1.3
Citrus	1.2	0.5	1.5
Other	0.1	0.1	2.3

Land Use/Loading Analysis

Watershed: S-4

Land Use	% of Watershed	% of Total P Load	% of Total N Load
Improved Pasture	47.4	63.7	20.8
Sugarcane	40.9	21.9	72.6
Urban	6.9	10.9	3.6
Wetlands	3.6	0.6	1.3
Crops, Sod	0.5	0.9	1.2
Dairy, Feedlots	0.5	1.9	0.3
Other	0.2	0.1	0.2

DOMINANT LAND USES IN ACRES BY BASIN

	Low Intensity Urban	High Intensity Urban	Truck Crops, Sod Farms*	Sugar Cane	Citrus	Dairy Farms, Cattle Feed Lots	Improved Pasture	Uplands	Wetlands
S-2	2,471	1,156	3,936	96,621	19	0	1,146	0	0
S-3	245	14	3,030	57,380	0	0	3,773	0	0
S-4	2,291	601	238	17,123	0	206	19,831	0	1,517
F.E. Ck.	2,007	15	29	0	3,508	56	80,280	156,726	52,646
S-71	2,392	22	1,575	0	8,812	27	56,871	29,615	2,582
U.T. Ck. N.S.	3,441	315	444	0	1,804	31,458	51,327	15,128	16,335
S-65A	351	107	2,491	0	1,179	42	42,608	47,559	7,576
S-65B	1,919	0	2,316	0	481	0	20,965	81,985	18,373
S-65C	12	0	0	0		19	31,025	11,609	5,923
S-65D	269	0	672	0	175	104	71,616	33,124	8,628
S-65E	480	7	621	0	3	37	26,586	8,673	1,183
Total	15,878 ac.	2,237 ac.	15,352 ac.	171,124 ac.	15,991 ac.	1,019 ac.	436,958 ac.	384,419 ac.	114,763 ac.

LAKE OKEECHOBEE
TOTAL LOADINGS FROM MAJOR BASINS AND DOMINANT LAND USES

Land Use	Acres	Total P (lbs/yr)	Total N (lbs/yr)
Low Intensity Urban	15,878	25,404.8	93,680.2
High Intensity Urban	2,237	5,368.8	26,844
Truck Crops, Sod Farms	15,352	29,168.8	509,686.4
Sugarcane	171,124	102,674.4	4,141,200.8
Citrus	15,991	14,391.9	9,171
Improved Pasture	436,958	1,991,397.7	4,020,013.6
Uplands	384,419	34,597.7	76,883.8
Wetlands	114,763	22,952.6	562,338.7
Total	1,156,722	2,225,956.7	9,439,818.5

APPENDIX II

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APPENDIX II

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APPENDIX III

LAND OWNERSHIP INFORMATION

General Description of Land Ownerships

A. Taylor Creek/Nubbin Slough Basin

Size-Acres	No. of Parcels	Total Acres
0-40	424	4731
41-100	17	1246
101-320	18	3613
321-640	17	8708
641-1000	10	7950
1001-2000	11	15621
2001-4000	6	17549
4001-8500	5	31864
TOTALS	508	91283

C. C-41 (S-71 Basin)

Size-Acres	No. of Parcels	Total Acres
0-40	52	1142
41-100	29	1946
101-320	31	6007
321-640	8	3282
641-1000	4	3557
1001-2000	12	19118
2001-4000	3	8611
4001-8500	3	17044
8501-12000	0	0
12001-27000	2	40600
TOTALS	144	101776

F. Fisheating Creek Basin

Size-Acres	No. of Parcels	Total Acres
0-40	0	0
41-100	36	3356
101-320	50	9220
321-640	15	7240
641-1000	13	10633
1001-2000	20	30370
2001-4000	5	13275
4001-8500	7	39935
8501-12000	1	8765
12001-27000	0	0
40000	1	40000
113200	1	113200
TOTALS	149	275988

G. S-2, South Shore, East Shore - EAA Basin

Size-Acres	No. of Parcels	Total Acres
0-100	52	2782
101-320	66	14563
321-640	19	9383
641-1000	9	7331
1001-2000	9	13088
2001-4000	7	18334
4001-8500	3	19808
8501-12000	2	21178
TOTALS	167	106467

H. S-3, S-236 Basin

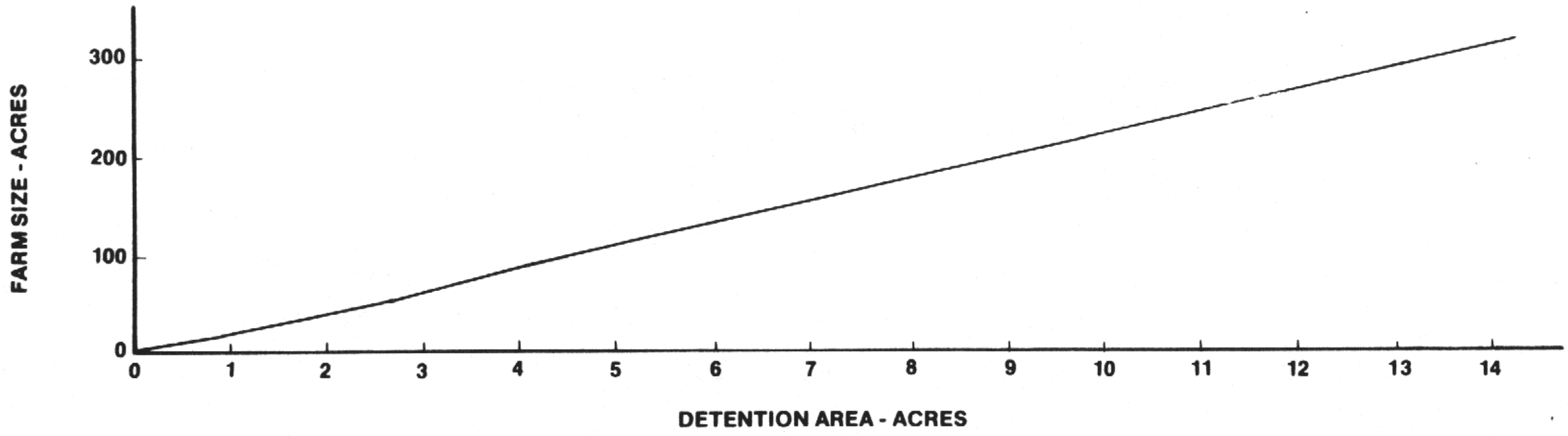
Size-Acres	No. of Parcels	Total Acres
0-100	14	817
101-320	12	2533
321-640	9	4851
641-1000	2	1633
1001-2000	4	5120
2001-4000	4	11605
5020	1	5020
16591	1	16591
22671	1	22671
TOTALS	48	70841

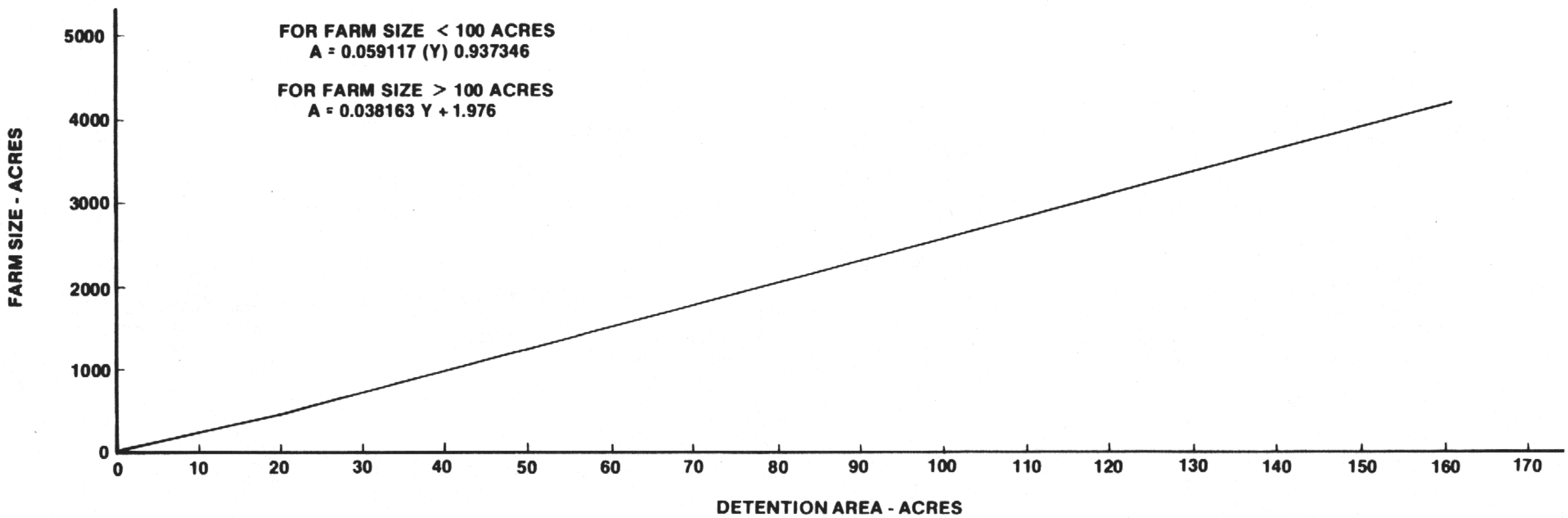
I. S-4 Basin

Size-Acres	No. of Parcels	Total Acres
0-100	16	916
101-320	10	1858
321-640	10	4364
641-1000	1	726
1001-2000	3	4320
2001-4000	2	4900
15360	1	15360
TOTALS	43	32444

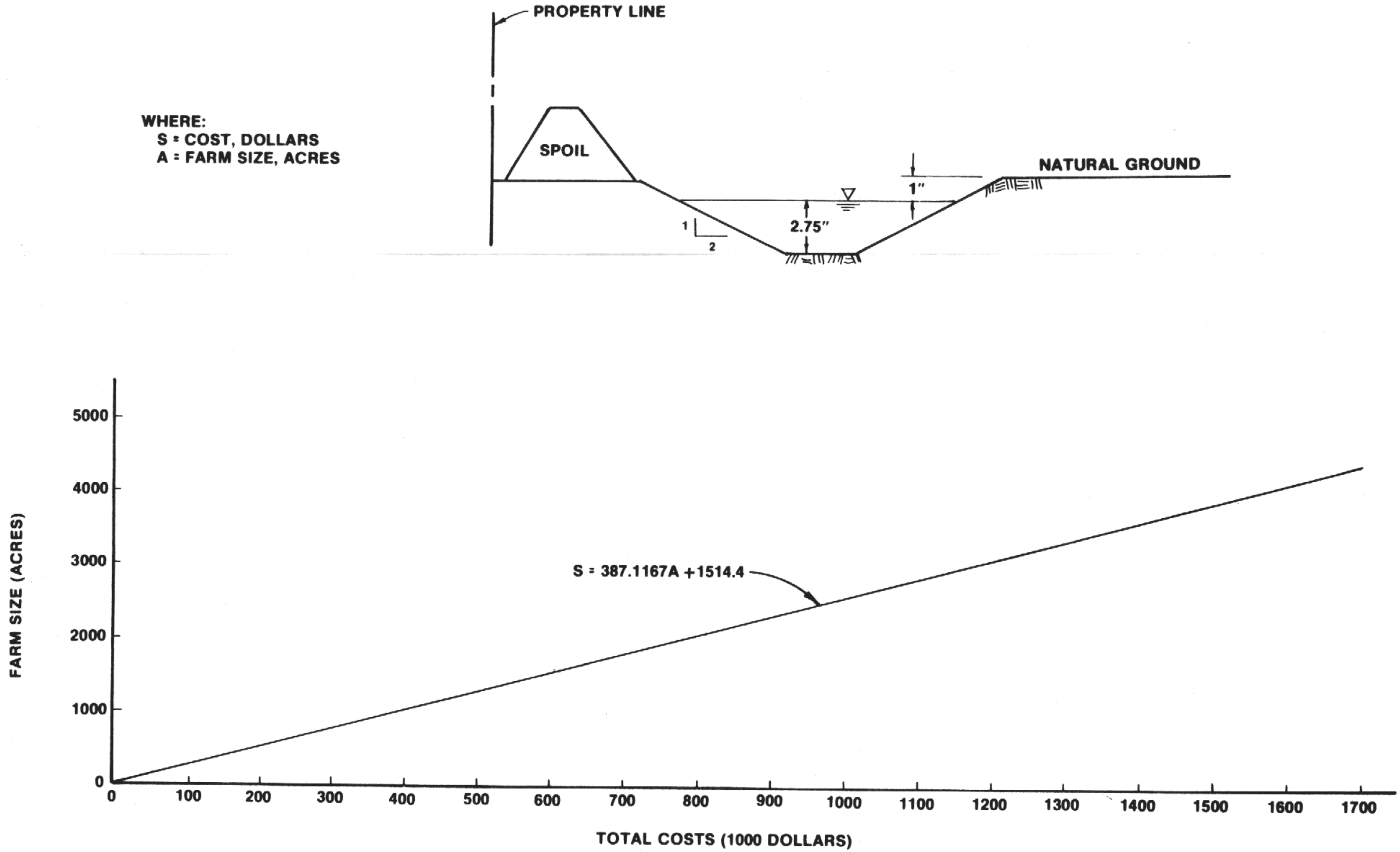
APPENDIX IV

EAA ON-SITE STORAGE CONSTRUCTION COSTS





AREA REQUIREMENTS FOR FIRST INCH RUNOFF DETENTION



CONSTRUCTION COSTS IN EAA FOR FIRST INCH RUNOFF DETENTION

APPENDIX V

SOUTH FLORIDA WATER MANAGEMENT DISTRICT PROJECT MAP